PUBLIC DOCUMENT . . . . No. 33.

EIGHTEENTH ANNUAL REPORT

OF THE

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1906.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1906.

Approved by

The State Board of Publication.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

ORGANIZATION.

Committee on Experiment Department.

JAMES DRAPER, *Chairman.*
J. LEWIS ELLSWORTH.
WILLIAM H. BOWKER.
CHARLES H. PRESTON.
SAMUEL C. DAMON.
THE PRESIDENT OF THE COLLEGE, *ex officio.*

Station Staff.

CHARLES A. GOESSMANN, PH.D., LL.D.,	*Honorary Director and Chemist* (fertilizers).
WILLIAM P. BROOKS, PH D., . . .	*Director and Agriculturist.*
GEORGE E. STONE, PH.D., . . .	*Botanist.*
JOSEPH B. LINDSEY, PH.D., . . .	*Chemist* (foods and feeding).
CHARLES H. FERNALD, PH.D., . .	*Entomologist.*
FRANK A. WAUGH, M.S., ...	*Horticulturist.*
J. E. OSTRANDER, C.E., ...	*Meteorologist.*
HENRY T. FERNALD, PH.D., . . .	*Associate Entomologist.*
FREDERICK R. CHURCH, B.SC., . .	*Assistant Agriculturist.*
NEIL F. MONAHAN, B.SC., ...	*Assistant Botanist.*
HENRI D. HASKINS, B.SC., . . .	*First Assistant Chemist* (fertilizers).
EDWARD G. PROULX, B.SC., . . .	*Second Assistant Chemist* (fertilizers).
E. THORNDIKE LADD, D.SC., . . .	*Third Assistant Chemist* (fertilizers).
EDWARD B. HOLLAND, M.S., . . .	*First Chemist* (foods and feeding).
PHILIP H. SMITH, B.SC., ...	*Assistant Chemist* (foods and feeding).
ARTHUR C. WHITTIER, B.SC., . . .	*Assistant Chemist* (foods and feeding).
FRANK G. HELYAR, B.SC., . . .	*Inspector* (foods and feeding).
SUMNER R. PARKER, B.SC., . . .	*Dairy Tester* (foods and feeding).
ROY F. GASKILL, ...	*Assistant in Foods and Feeding.*
WALTER B. HATCH, B.SC., . . .	*Assistant Horticulturist.*
CLIFTON H. CHADWICK, ...	*Observer.*

REPORT OF THE DIRECTOR.

WILLIAM P. BROOKS, DIRECTOR.

The work of the Hatch Experiment Station during the past year has progressed under favorable conditions. The only changes in the station staff have been a few affecting minor positions, which are elsewhere referred to. There has accordingly been no interruption in the lines of investigation which have been in progress.

Besides the monthly meteorological bulletins, during the past year four other bulletins have been issued: Nos. 103 and 104 on the subject of fertilizers and the results of analyses thereof; No. 105 on tomatoes under glass and methods of pruning tomatoes; and No. 106 on condimental stock and poultry foods.

The work of the section of our division of chemistry having to do with fertilizers shows that the conditions of the fertilizer trade in the State are substantially the same as during recent years. The manufacturers and dealers still offer an enormous number of different brands of so-called complete and special fertilizers in the markets. The number of samples analyzed during the past year is 511, representing 313 distinct brands. There can be no doubt that the business of manufacturing and selling fertilizers might easily be greatly simplified; that a great reduction in the number of brands offered, without loss in any direction, is possible; and that the result of such simplification and reduction in the number of brands would be that fertilizers sufficiently varied for every purpose could be furnished to the farmers at lower prices than those at present prevailing.

The fertilizer section of our division of chemistry has during the past year analyzed the usual number of samples of miscellaneous materials, wood ashes, lime ashes, soils, etc. Such samples as are sent in by the farmers are usually analyzed and the results reported without charge.

The bulletin on tomatoes under glass is an important contribution to knowledge on the best methods of handling this crop, which is coming to be one of much importance in this State. Bulletin No. 106, on condimental stock and poultry foods, presents analyses of a large number of foods coming under these classes. It discusses the utility of such foods, and their cost as compared with the more common food stuffs. It is clearly shown that their cost is in excess of what appears to be a perfectly fair estimate of their value. The bulletin presents a brief résumé of the results of experiments in the use of stock and poultry foods, which tends to show that the claims made for these foods are not justified by facts. The results of an experiment in the department of foods and feeding are presented and discussed, the conclusion being that the food under trial (Pratt's) did not appear to be superior in any way to a like mixture of corn meal and wheat middlings, while the cost was considerably greater.

In the division of foods and feeding, under Dr. J. B. Lindsey, a number of other important lines of investigation have been followed during the year. A somewhat full statement of the results in a number of these will be found in Dr. Lindsey's report, which is transmitted herewith. Among the more important results of these investigations are the following points: Bibby's dairy cake, a food which has been persistently urged upon the attention of our milk producers, has been carefully tested, but has been found to be less satisfactory from an economical point of view than some of the ordinary food stuffs.

Eureka corn has been carefully compared with Sibley's Pride of the North corn, from the standpoint both of production and of food value. It is found that, although the Eureka gives a much heavier yield, the excess in weight is made up almost exclusively of water. The food value of the product of an acre of Eureka corn is not equal to the food value of the much smaller acre product of Sibley's Pride of the North.

Wheat bran has been compared with corn silage, in connection in both cases with some of the more nitrogenous concentrates, as food for milch cows. The results indicate that silage is equally as satisfactory as the bran, and that by substitution of silage for the bran the necessary outlay for purchased foods in milk production can be greatly reduced.

This division has carried out an interesting investigation into the conditions prevailing in milk production in Amherst and neighboring towns. It is found that the conditions are often quite unsanitary; that bacteria are frequently exceedingly numerous in the milk, indicating improper methods of handling; and that in general there is urgent need of improvement. In the judgment of Dr. Lindsey, the results of this investigation indicate the desirability of the establishment of some regular system of inspecting dairies. It is believed that this is something which consumers in increasing numbers will be likely to insist upon in the near future.

In the horticultural division the only investigation sufficiently advanced to justify report is that undertaken, and in part reported upon in our last annual report, on methods of pruning peach trees injured by winter-killing. It will be remembered that four systems were under trial: no pruning, light pruning, moderate pruning, and severe pruning. Severe pruning consisted in removing nearly all the branches of the injured tree. The observations of another year lead to the conclusion that this system cannot be recommended. A more moderate pruning, consisting of the removal of from one-third to one-half of the growth of the previous year, seems to have given results which are on the whole most satisfactory; and such pruning is recommended in all cases when the wood has been injured by winter-killing. If only the fruit buds have been destroyed by the winter, it is recommended to prune back the previous season's growth severely, leaving only two or three buds.

In the entomological division, experiments are in progress with a view to determining the definite strength of hydrocyanic acid gas which can be used with safety on plants in greenhouses under varying conditions of growth.

In the report of the division of botany and vegetable pathology will be found a discussion of the general conditions as affecting plant diseases during the past year; references to the somewhat unusual attack of the potato rot fungus (*Phytopthora infestans*) on the tomato; and a discussion of the causes of sun scald and the browning of the foliage of conifers and other evergreens.

The report of the vegetable pathologist, Dr. George E. Stone, includes also a suggestive discussion on winter-killing as affecting trees and shrubs, as a result of the exceptionally cold winters 1902–03 and 1903–04.

The great importance of suitable aeration of the soil for perfect germination of certain seeds is brought out by another paper. The effects of sterilization of soils respectively rich and low in organic matter on germination and the growth of plants have been investigated. It has been found that, if the soil is rich in organic matter, sterilization is favorable both to germination and subsequent growth; but if the soil contains little organic matter, such treatment is unfavorable.

The influence of treating seeds in soil decoctions of varying strengths has been carefully studied, and it is shown that such decoctions from sterilized soil when highly diluted exercise a favorable effect on germination. The report of Dr. Stone includes also the presentation and discussion of results of various methods of seed selection. The conclusion is that, for seeds adapted to that method of handling, the use of sieves of suitable mesh as a means of separating the small and inferior seeds is strongly to be recommended. The use of other methods of separation in the case of seeds which cannot be successfully handled by sifting is urged, as being of much importance.

The work of the agricultural division during the past year has followed the usual lines, and is elsewhere briefly summarized.

Among the different bulletins and reports which have been issued by the station, the following are still in stock and can be furnished on demand: —

No. 3. Tuberculosis.
No. 27. Tuberculosis in college herd; tuberculin in diagnosis; bovine rabies; poisoning by nitrate of soda.
No. 33. Glossary of fodder terms.
No. 41. On the use of tuberculin (translated from Dr. Bang).
No. 64. Analyses of concentrated feed stuffs.
No. 67. Grass thrips; treatment for thrips in greenhouses.
No. 75. Fertilizer analyses.
No. 76. The imported elm-leaf beetle.
No. 77. Fertilizer analyses.
No. 81. Fertilizer analyses; treatment of barnyard manure with absorbents; trade values of fertilizing ingredients.
No. 82. Orchard management; cover crops in orchards; pruning of orchards; report on fruits.
No. 83. Fertilizer analyses.
No. 84. Fertilizer analyses.
No. 87. Cucumbers under glass.
No. 89. Fertilizer analyses; ash analyses of plants; instructions regarding sampling of materials to be forwarded for analysis.
No. 90. Fertilizer analyses.
No. 92. Fertilizer analyses.
No. 95. Fertilizer analyses; notes on barnyard manure; trade values of fertilizing ingredients.
No. 96. Fungicides; insecticides; spraying calendar.
No. 97. A farm wood lot.
No. 98. Inspection of concentrates.
No. 99. Dried molasses beet pulp; the nutrition of horses.
No. 100. Fertilizer analyses; market values of fertilizing ingredients.
No. 102. Analyses of manurial substances and fertilizers; market values of fertilizing ingredients.
No. 103. Analyses of manurial substances; instructions regarding sampling of materials to be forwarded for analysis; instructions to manufactures, importers, agents and sellers of commercial fertilizers; discussion of trade values of fertilizing ingredients.
No. 104. Analyses of manurial substances and licensed fertilizers; market values of fertilizing ingredients.
No. 105. Tomatoes under glass; methods of pruning tomatoes.

No. 109. Condimental stock and poultry foods.
Special bulletin, — The coccid genera Chionaspis and Hemichionaspis.
Technical bulletin, No. 1, — Greenhouse Aleyrodes; strawberry Aleyrodes.
Technical bulletin, No. 2, — The graft union.
Index, 1888–95.
Annual reports, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906.

Of most of the other bulletins a few copies remain, which can be supplied only to complete sets for libraries.

The co-operation and assistance of farmers, fruit growers and horticulturists, and all interested directly or indirectly in agriculture, are earnestly requested. Communications may be addressed to the "Hatch Experiment Station, Amherst, Mass."

ANNUAL REPORT

OF GEORGE F. MILLS, *Treasurer* OF THE HATCH EXPERIMENT STATION OF MASSACHUSETTS AGRICULTURAL COLLEGE,

For the Year ending June 30, 1905.

Cash received from United States Treasurer,		$15,000 00
Cash paid for salaries,	$6,992 42	
for labor,	1,788 14	
for publications,	782 84	
for postage and stationery,	367 35	
for freight and express,	221 78	
for heat, light, water and power,	544 60	
for chemical supplies,	106 39	
for seeds, plants and sundry supplies,	410 48	
for fertilizers,	738 11	
for feeding stuffs,	379 78	
for library,	78 36	
for tools, implements and machinery,	398 37	
for furniture and fixtures,	162 26	
for scientific apparatus,	586 31	
for live stock,	127 05	
for travelling expenses,	158 46	
for contingent expenses,	25 00	
for building and repairs,	1,132 30	
		$15,000 00
Cash received from State Treasurer,	$13,625 00	
from fertilizer fees,	4,365 00	
from farm products,	1,512 95	
from miscellaneous sources,	3,463 70	
Balance June 30, 1904,	3,383 55	
		$26,350 20

Cash paid for salaries,	$13,678 34	
for labor,	2,337 59	
for publications,	651 50	
for postage and stationery,	308 52	
for freight and express,	136 62	
for heat, light, water and power,	1,021 32	
for chemical supplies,	615 56	
for seeds, plants and sundry supplies,	451 51	
for fertilizers,	7 39	
for feeding stuffs,	613 28	
for library,	92 08	
for tools, implements and machinery	17 33	
for furniture and fixtures,	174 11	
for scientific apparatus,	735 74	
for live stock,	172 00	
for travelling expenses,	1,400 79	
for buildings and repairs,	198 86	
Balance,	3,737 66	
		$26,350 20

I, Charles A. Gleason, duly appointed auditor of the corporation, do hereby certify that I have examined the accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ended June 30, 1905; that I have found the same well kept and classified as above; that the receipts for the year from the Treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000; for all of which proper vouchers are on file and have been by me examined and found correct, thus leaving no balance of the $15,000; and that $3,737.66 are left of the State appropriation and of funds received from miscellaneous sources.

CHARLES A. GLEASON,
Auditor.

AMHERST, Aug. 7, 1905.

REPORT OF THE METEOROLOGIST.

J. E. OSTRANDER.

The attention of this division during the year has been largely confined to the work of making the usual observations of the various weather phenomena and a proper tabulation of these records, together with such computations as are found necessary for the purpose of comparison. The installation of some new apparatus has required some changes in the manner of tabulation, but the only effect on the results is to render them more accurate.

At the beginning of each month the usual bulletin of four pages has been issued, giving the more important daily records and monthly means, together with a summary of the results. The annual summary will be issued as a part of the December bulletin. In addition to issuing the bulletins, a considerable number of letters have been required to answer specific inquiries regarding rainfall, temperature and other features of the weather.

This station, being one of the voluntary observers' stations of the United States Weather Bureau, has furnished the section director at Boston with the usual monthly reports, and has also agreed to furnish the weekly snow reports during the winter. A phenological record has also been made, and a copy furnished the section director at his request.

The local forecast official at Boston has furnished this station with the local weather predictions daily except Sundays, and the proper signals have been displayed from the flagstaff on the tower. It was found necessary to shorten the flagstaff a few feet, but this has not resulted in making the signals less noticeable.

Owing to the unsatisfactory records made by some of the Draper self-recording instruments in the tower, it was decided to secure some of other make whose records would be more precise. Accordingly, a triple electric register for recording sunshine, rainfall and wind velocity was purchased from Julien P. Friez, and during the summer vacation the wiring was done to put it in working order. The sunshine recorder was mounted on top of the tower and connected by wires to the register in the tower. Two Edison primary batteries furnish the current required to operate the register at intervals of one minute while the sun is shining. A tipping-bucket rain gauge on the campus is connected to the register in the tower by more than a thousand feet of wire, and each one-hundredth of an inch of rainfall is registered. This furnishes a record of the rate of precipitation during a storm, as well as the total amount. The record is also checked by measurement in a standard rain gauge. A small anemometer of the Weather Bureau pattern was mounted on top of the tower in place of the Draper rain gauge, which was taken down, and each mile of wind travelled is recorded on the register below. As the drum on which all the above-mentioned records are made travels at a rate of nearly three miles per hour, the records are very distinct, and variations in rate of wind movement, as well as in the rainfall, are easily noted. A set of maximum and minimum thermometers of the Weather Bureau pattern was purchased during the year, to replace others that were greatly worn.

The assistant observer, Mr. C. H. Chadwick, was advanced to the position of observer in June, succeeding Mr. G. W. Patch.

REPORT OF THE AGRICULTURISTS.

WM. P. BROOKS; ASSISTANTS, F. R. CHURCH, S. B. HASKELL.

The work of the agricultural department for the past year has closely followed the lines of recent years. The leading object of our work is, by long-continued comparative experiments, to throw light upon some of the many problems connected with the use of manures and fertilizers. The results of a single year may be of value as a guide to practice, but it is important to know concerning any given system, not alone the immediate effect upon the crop, but the ultimate effect upon the soil as well. This is made manifest only by continued manuring along definite lines. Thus, by long-continued comparison of different materials which may be used respectively as sources of any given plant food element, we may hope to determine their real and average relative value, and, by suitable rotation of crops, their relative suitability also for different plants. By continued experiment along definite lines in successive years we may hope, moreover, to discover the relation of season to the fertilizer efficiency of the different fertilizer materials under comparison. With definite knowledge concerning immediate effect upon the crop, ultimate effect upon the soil and differences in effect due to variations in seasons, we shall be in a position to give advice of value both to the farmer seeking to produce crops at lowest cost and to the fertilizer manufacturer. The work carried on in the department during the past season has involved the care of 244 field plots in our various fertilizer and variety tests, 150 closed plots and 245 pots in vegetation experiments. The work in the closed plots and the vegetation experiments serve as valuable checks upon the accuracy of field work, and enable us to extend the scope of our investigations. Besides the care for all this work, we have a grass garden including 48 species and 7 varieties, most of which occupy one square rod each. Our work with poultry has followed the general lines of investigation of earlier years, the principal subject under investigation being the relations of different foods and food combinations to egg production. A detailed report of results obtained will be at this time presented for but a small number of the experiments in progress.

The principal subjects of inquiry discussed, and the more important results, very briefly stated, are as follows: —

I. — To determine the relative value of barnyard manure, nitrate of soda, sulfate of ammonia and dried blood, as sources of nitrogen. The crop of this year was mixed oats and peas for hay; and, on the basis of yield, the nitrogen-furnishing materials rank in the following order: nitrate of soda, dried blood, sulfate of ammonia, and barnyard manure. On the basis of increase, as compared with no-nitrogen plots, taking into account all the crops grown since the experiment began, the materials rank as follows: nitrate of soda, 100 per cent.; dried blood, 68.72 per cent.; sulfate of ammonia, 60.78 per cent.; barnyard manure, 80.58 per cent.

II. — To determine the relative value of muriate as compared with high-grade sulfate of potash for field crops. The results of this year indicate the sulfate to be superior to the muriate for clover, for rhubarb, and for blackberries.

III. — To determine the relative value of different potash salts for field crops. The salts under comparison are high-grade sulfate, low-grade sulfate, kainite, muriate, nitrate, carbonate, and silicate. The crop of this year was soy beans. The different potash salts rank in the following order: carbonate, high-grade sulfate, silicate, nitrate, muriate, low-grade sulfate, and kainite. The crop where the latter salt was used was by far the poorest in the field, being much lower than the crop of the plots to which no potash has been applied for the past eight years.

IV. — To determine the relative value in crop production of a fertilizer mixture rich in potash, as compared with one representing the average of special corn fertilizers purchasable in our markets. The crop of this year was hay, — mixed timothy, red-top and clovers. The crops were substantially equal; but, as the cost of fertilizers is lower where the fertilizer richer in potash is used, the advantage is with that combination of materials.

V. — To determine the relative value in corn and hay production of a moderate application of manure alone, as compared with a smaller application of manure used in combination with 160 pounds of high-grade sulfate of potash per acre. The crop of this year was hay, — mixed timothy, red-top and clovers. The larger average yield was produced on the combination of manure and potash; and, as this combination costs $6.40 less per acre than the larger quantity of manure alone, the advantage in favor of the combination is decisive.

VI. — To determine which is better economy, to spread manure as hauled from the stable during the winter, or to place in a large heap to be spread in spring. This experiment occupies five pairs of plots. The spring application gave the better yield in all cases, but the difference was not sufficiently large to cover the larger cost of the extra handling involved in the case of the manure spread in the spring. The winter of 1904–05, however, was exceptionally favorable to good results from application at that season, as there was little or no wash over the surface.

VII. — To determine the economic result of using in rotation on grass lands: the first year, barnyard manure, 8,000 pounds per acre; the second year, wood ashes, 1 ton per acre; and the third year, bone meal, 600, and muriate of potash, 200, pounds per acre. The average yield of hay during the past season, all three systems of manuring being represented, on a total area of about 9 acres, is at the rate of about 4,840 pounds of hay per acre. The average for the thirteen years during which the experiment has continued, 1893–1905, inclusive, is 6,479 pounds.

VIII. — To determine whether the application of nitrate of soda after the harvesting of the first crop will give a profitable increase in the rowen crop. The increases produced in the four pairs of plots under comparison were relatively small except in one instance. Nitrate applied at the rate of 250 pounds per acre gave an apparent increase of nearly 1 ton of rowen, which is considerably more than sufficient to cover the cost of the nitrate.

IX. — To test the relative value for the production of garden crops of fertilizers supplying respectively nitrogen and potash, when used with manure. The nitrogen fertilizers compared are dried blood, nitrate of soda and sulfate of ammonia. The use of the nitrate is attended with the greatest profit. On the basis of total crops produced, the relative standing of the different nitrogen fertilizers is: for the early crops, nitrate of soda, 100 per cent.; dried blood, 95.67 per cent.; sulfate of ammonia, 63.08 per cent.; for the late crops, nitrate of soda, 100 per cent.; dried blood, 98.77 per cent.; sulfate of ammonia, 79.52 per cent.

The potash salts under comparison are high-grade sulfate and muriate. For the fifteen years the relative standing of these fertilizers is: for the early crops, sulfate of potash, 100 per cent.; muriate of potash, 94.66 per cent.; for the late crops, sulfate of potash, 97.9 per cent.; muriate of potash, 100 per cent.

X. — To determine whether alfalfa is a profitable crop in Massachusetts. A large number of experiments tried during the past eight or ten years indicates that it is quite doubtful whether alfalfa can be successfully grown under our climatic conditions.

XI. — Comparison of different feeds and feed combinations furnishing the essential nutrients in varying proportions for laying hens. The results indicate corn to have superior merit among the different grains for the production of eggs, considered from the standpoint both of total number and economy of production. Rice is somewhat superior in number of eggs produced to corn, but the cost is so great as to render its use inexpedient.

I. — Manures and Fertilizers furnishing Nitrogen compared. (Field A.)

To make clear the plan of the experiment, which is continuous, I quote from the seventeenth annual report: —

The experiments in Field A have two principal objects in view: first, to compare the efficiency (as measured by crop production) of a few standard materials which may be used on the farm as sources of nitrogen; second, to determine to what extent the introduction of a legume will render the application of nitrogen to a succeeding crop of another family unnecessary. The field includes eleven plots of one-tenth acre each. A full description of the plan followed will be found in the twelfth annual report of the Hatch Experiment Station. The materials furnishing nitrogen under comparison are barnyard manure, nitrate of soda, sulfate of ammonia and dried blood. With few and unimportant exceptions, each plot has been manured in the same way since 1890. All the plots annually receive equal and liberal amounts of materials supplying phosphoric acid and potash. Three plots in the field have had no nitrogen applied to them since 1884; the materials under comparison on the other plots in the field are applied in such quantities as to furnish nitrogen at the rate of 45 pounds per acre to each. Barnyard manure is applied to one plot, nitrate of soda to two, sulfate of ammonia to three and dried blood to two plots. The potash applied to these plots is supplied in the form of muriate to six plots, namely, 1, 3, 6, 7, 8 and 9. It is supplied in the form of low-grade sulfate to four plots, namely, 2, 4, 5 and 10.

The crops grown in this experiment previous to this year in the order of their succession have been: oats, rye, soy beans, oats, soy beans, oats, soy beans, oats, oats, clover, potatoes, soy beans, potatoes, soy beans, potatoes.

The condition of the soil of this field during the last year or two had indicated quite clearly that it would be benefited by liming. Freshly water-slaked lime was used. It was applied by the use of Kemp's manure spreader, adjusted with a view to applying lime as closely as possible at the rate of 1 ton to the acre. The amount actually applied to

$1\frac{1}{10}$ acre was 2,395 pounds, so that the lime was used in slightly greater quantity than intended. The work of the spreader in applying lime is quite satisfactory. There is no difficulty in adjusting it to apply any desired amount with substantial accuracy. Any chance that the amounts applied to the different plots in such experiments as those in progress on Field A will differ is avoided by driving the spreader in applying the lime the full length of the field across the plots.

The crop of this year was oats and peas. The lime was applied on April 26, and plowed in, and Canada peas at the rate of $1\frac{1}{2}$ bushels per acre were sown on April 28, and deeply harrowed in. On April 29 the fertilizers were applied, and harrowed in. The oats were of the Clydesdale variety. They were sown at the rate of 1 bushel to the acre on May 1, and harrowed in. No accidental conditions likely to interfere with the experiment were noted, although the rank growth on the plots receiving nitrogen in the most highly available form (nitrate of soda and sulfate of ammonia) resulted in considerable lodging, which no doubt decreased the yield on those plots.

The rates of yield on the several plots and the source of nitrogen on each are shown in the following table : —

Yield of Oats and Peas per Acre.

Plots.	Nitrogen Fertilizers used.	Hay (Pounds).
0, . .	Barnyard manure, ...	4,950
1, . .	Nitrate of soda (muriate of potash), ...	6,900
2, . .	Nitrate of soda (sulfate of potash), ...	7,000
3, . .	Dried blood (muriate of potash), ...	6,700
4, . .	No nitrogen (sulfate of potash), ...	4,350
5, . .	Sulfate of ammonia (sulfate of potash), ...	5,650
6, . .	Sulfate of ammonia (muriate of potash), ...	6,600
7, . .	No nitrogen (muriate of potash), ...	4,800
8, . .	Sulfate of ammonia (muriate of potash), ...	6,900
9, . .	No nitrogen (muriate of potash), ...	3,900
10, . .	Dried blood (sulfate of potash), ...	6,500

It will be noticed that the yield on the three no-nitrogen plots (4,7,9) is much below the yield obtained on any of the plots where fertilizers supplying nitrogen were used. There was a fair proportion of peas in the crop, but, in spite of the fact that peas are usually able to take a considerable proportion of their nitrogen from the air, it is very clear that it will be unwise, in the case of a mixed crop including a legume and a non-legume, to depend to any great extent upon this atmospheric source of supply. The average yield of the three no-nitrogen plots was at the rate of 4,350 pounds of hay per acre. The average yield of the nitrogen plots was at the rate of 6,400 pounds per acre. Here is a difference of a little more than 1 ton per acre, which is far more than sufficient to cover the cost, $7.85, of the amounts in which such fertilizer was used. It will be noticed, further, that the yield on the plot to which barnyard manure is annually applied is much below that on even the poorest plot to which a nitrogen fertilizer was applied. The manure in question was put on at the time of preparing the soil in the spring, and evidently the nitrogen it contained did not become in large degree available in season to benefit crops making their growth so early in the growing season as oats and peas. The average yields of this year on the several fertilizers are shown in the following table: —

Fertilizers used.	Hay (Pounds).
Average of the no-nitrogen plots (4, 7, 9),	4,350
Average of the nitrate of soda plots (1, 2),	6,950
Average of the dried-blood plots (3, 10),	6,600
Average of the sulfate of ammonia plots (5, 6, 8),	6,383

As the result of experiments previous to this year, it has been found that the materials furnishing nitrogen have produced crops in the following relative amounts: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	96.02
Dried blood,	90.83
Sulfate of ammonia,	88.62
No nitrogen,	72.11

Similar averages for this year are as follows: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	94.96
Sulfate of ammonia,	91.84
Barnyard manure,	71.22
No nitrogen,	62.60

Combining the results showing relative standing in 1905 with similar figures for all the years previous to 1905, the relative standing is as follows: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	94.47
Dried blood,	91.09
Sulfate of ammonia,	88.83
No nitrogen,	71.52

The figures showing relative standing of the different materials furnishing nitrogen as compared with the no-nitrogen plots so far given are based upon the total yield. If we compare the different materials used as sources of nitrogen on the basis of increase in crop rather than on the basis of total product, they rank to date for the entire period of the experiment, 1890 to 1905, inclusive, as follows: —

Relative Increases in Yields (Average for the Sixteen Years).

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	80.58
Dried blood,	68.72
Sulfate of ammonia,	60.78

Whatever the method of comparison, the superiority of the results obtained from the use of nitrate of soda is very apparent. In estimating the significance of the figures, the fact must not be lost sight of that the four different materials, nitrate, dried blood, sulfate of ammonia and barnyard manure, are applied in this experiment in amounts furnishing precisely equal quantities of nitrogen to each plot where they are used. At current prices, a pound of nitrogen can be purchased at lower cost in nitrate of soda than in almost any other material; and the advisability, therefore, of depending largely upon the nitrate as a means of supplying the important element nitrogen, becomes strikingly evident.

II. — The Relative Value of Muriate and High-grade Sulfate of Potash. (Field B.)

This experiment, which has been in progress since 1892, was designed to test the relative value of muriate and high-grade sulfate of potash used continuously upon the same soil. These salts since 1900 have been annually applied at the rate of 250 pounds each per acre. There are ten plots in the field, each containing about 1/7 of an acre. Five of these receive muriate of potash, and these plots alternate with the same number of plots which are yearly manured with sulfate of potash. Each plot in the field is manured annually with fine-ground bone at the rate of 600 pounds per acre. The crops grown in this field this year have included soy beans, celery, asparagus, rhubarb, raspberries, blackberries and clovers. The yields of the three crops, asparagus, raspberries and blackberries, have been small, and the differences in the results on the different potash salts did not appear to be sufficient to be of much significance. There was, however, a very marked difference in the extent to which the blackberry bushes on the two potash salts winter-killed. Those on the plot which has annually received an application of sulfate of potash were killed back much less seriously than the bushes on the muriate of potash plot. There was a marked difference in the growth of the celery on the two potash salts, that on the muriate being much better than that on the sulfate. This fact is reported at this time without comment, as it seems to the writer probable that some accidental cause, not connected directly with the system of manuring, unfavorably influenced the growth on the poorer plot. Six plots in the field have been in clover during the past year. All of these plots were sown to clover in the late summer of 1904, one pair of plots each (muriate and sulfate) with Alsike, Medium and Mammoth clovers. The clover on all plots germinated well, but early showed a very unhealthy condition on the plots occupied both by the Medium and Mammoth red clovers. The young plants early turned yellow and gradually disappeared. So poor was the condition of these varieties of clover this spring that it was decided to plow them up. The unhealthy condition is thought to have been connected with a deficiency of lime in the soil, and these plots accordingly received an application of freshly slaked lime at the rate of about 1 ton to the acre. They were then plowed and reseeded to the same varieties of clover. The crops were cut on August 11, but, being much mixed with weeds, as was to be expected in the case of spring-sown clover, the product was not weighed. The Alsike clover upon the plots sown in the summer of 1904 gave one fair crop.

The yield on the muriate was at the rate of 3,986 pounds per acre; on the sulfate, 4,000 pounds. These figures do not accurately indicate the relative condition of the clover, for the growth on both plots was somewhat mixed with other grasses, which were much more abundant on the muriate of potash than on the sulfate, where the clover was very clearly much superior to that on the other plot. The rhubarb on both potash salts gave a heavy growth. The rates of yield per acre were as follows: —

Muriate v. High-grade Sulfate of Potash (Rhubarb). — Yields per Acre (Pounds).

Fertilizers used.	Stalks.	Leaves.
Muriate of potash,	23,148	19,249
Sulfate of potash,	23,729	20,344

These yields are much heavier than last year, as the rhubarb is now more fully established, and the difference in favor of the sulfate of potash is still greater than previously.

III. — Comparison of Different Potash Salts for Field Crops. (Field G.)

This experiment for comparison of different potash salts was begun in 1898. The field contains forty plots, of about one-fortieth of an acre each. The plots are fertilized in five series of eight plots each, each series including a no-potash plot and one plot for each of the potash salts under comparison. Those salts are kainite, high-grade sulfate, low-grade sulfate, muriate, nitrate, carbonate and silicate. Each is applied annually to the same plot, and all are used in such amounts as to furnish equal potash to each plot. In the quantities employed the different salts supply annually actual potash at the rate of 165 pounds per acre. All plots are equally manured with materials furnishing fairly liberal amounts of nitrogen and phosphoric acid.[1]

The crops grown in this experiment since 1898 in order of succession up to the present year have been : —

1898. Medium Green soy beans.
1899. Potatoes.
1900. Plots 1–8, cabbage ; 9–24, Medium Green soy beans ; 25–40, cow peas.
1901. 1–8, wheat ; 9–40, corn.
1902. Clover.
1903. Clover.
1904. 1–16, cabbage ; 17–40, corn.
1905. Soy beans.

The results with the crops of last year, cabbages and corn, were rather indecisive, and were not reported in detail. The most striking observation in connection with the results of last year was the relatively low yields on the silicate of potash and the relatively high yields on the nitrate and carbonate. The crop in 1905 was the Medium Green soy bean. The season was favorable to the crop, which, with one exception, to be presently noted, appeared to be affected by no disturbing accidental conditions. A circular area, extending entirely across Plot 10 and a short distance into both plots 9 and 11, was early affected by some unknown cause, which within a relatively short time resulted in the death of the plants growing there. It is estimated that the total number of plants in Plot 10 thus destroyed was from one-quarter to one-third of the total number of plants in the plot. The proportion of plants destroyed in plots 9 and 11 was relatively small.

At a period very early in the growth of the crop it was noticed that the leaves on all the plots to which kainite is applied as a fertilizer were abnormal. Practically all the

---

[1] Sixteenth annual report, Hatch Experiment Station.

leaves on plants on these plots early became very much crinkled. They were smaller than normal leaves, and there were numerous areas near the margins of some of the leaves where the tissues died. This appearance was repeated with such perfect regularity on each one of the plots (2, 10, 18, 26, 34) to which kainite was applied that it is impossible to doubt that the effect was due to constituents found in this fertilizer. It was clearly physiological in its origin. Whether due to the large amounts of chlorides contained in the kainite applied to these plots we are not at present certain; but, in view of the fact that potassium chloride has in a number of instances been shown to be distinctly inferior as a source of potash for soy beans in comparison with other salts in our experiments, it seems probable that such was the case. The potash salts used on the different plots and the rates of yield of beans per acre are shown in the following table: —

Yields per Acre.

Plots.	Potash Salt.	Beans (Bushels).	Straw (Pounds).
1, ...	No potash, ...	24.14	2,120
2, ...	Kainite, ...	18.62	1,210
3, ...	High grade sulfate, ...	26.90	2,000
4, ...	Low grade sulfate, ...	25.17	1,800
5, ...	Muriate, ...	22.41	1,640
6, ...	Nitrate, ...	24.14	1,960
7, ...	Carbonate, ...	32.41	2,280
8, ...	Silicate, ...	22.07	1,540
9, ...	No potash, ...	18.79	1,400
10, ...	Kainite, ...	11.38	1,600
11, ...	High grade sulfate, ...	21.04	2,080
12, ...	Low-grade sulfate, ...	22.42	2,280
13, ...	Muriate, ...	22.07	2,240
14, ...	Nitrate, ...	25.87	2,800
15, ...	Carbonate, ...	28.28	2,700
16, ...	Silicate, ...	26.90	2,740
17, ...	No potash, ...	24.83	2,380
18, ...	Kainite, ...	17.24	1,540
19, ...	High-grade sulfate, ...	25.52	1,940
20, ...	Low-grade sulfate, ...	24.14	1,760

Yields per Acre — Concluded.

Plots.	Potash Salt.	Beans (Bushels).	Straw (Pounds).
21, . . .	Muriate, ...	30.69	1,820
22, . . .	Nitrate, ...	26.21	2,160
23, . . .	Carbonate, ...	26.90	2,260
24, . . .	Silicate, ...	26.21	2,080
25, . . .	No potash, ...	22.41	1,780
26, . . .	Kainite, ...	19.31	1,240
27, . . .	High-grade sulfate, ...	31.72	2,080
28, . . .	Low-grade sulfate, ...	25.87	1,760
29, . . .	Muriate, ...	24.48	1,900
30, . . .	Nitrate, ...	15.86	1,240
31, . . .	Carbonate, ...	26.55	1,960
32, . . .	Silicate, ...	23.19	1,600
33, . . .	No potash, ...	23.45	1,800
34, . . .	Kainite, ...	18.26	1,160
35, . . .	High-grade sulfate, ...	24.14	1,820
36, . . .	Low-grade sulfate, ...	16.21	960
37, . . .	Muriate, ...	15.52	1,040
38, . . .	Nitrate, ...	24.83	2,020
39, . . .	Carbonate, ...	24.14	2,240
40, . . .	Silicate, ...	28.62	2,160

The influence of the different potash salts is somewhat more clearly brought out by the table below, which gives the average results for each of the potash salts employed :—

Soy Beans. — Average Yield per Acre.

Potash Salt.	Beans (Bushels).	Straw (Pounds).
No potash (plots 1, 9, 17, 25, 33), ...	22.72	1,896
Kainite (plots 2, 10, 18, 26, 34), ...	16.96	1,350
High-grade sulfate (plots 3, 11, 19, 27, 35), . . .	25.86	1,984
Low-grade sulfate (plots 4, 12, 20, 28, 36), . . .	22.76	1,712
Muriate (plots 5, 13, 21, 29, 37), ...	23.03	1,728
Nitrate (plots 6, 14, 22, 30, 38), ...	23.38	2,036
Carbonate (plots 7, 15, 23, 31, 39), ...	27.86	2,288
Silicate (plots 8, 16, 24, 32, 40), ...	25.40	2,024

It will be noticed that the average rate of yield on all plots to which potash salts are applied, with the exception of those where kainite is the source of potash, is greater than on the no-potash plots. The average yield on the kainite, on the other hand, is much below the average on the no-potash plots. Examination of the longer table shows that this inferiority of kainite was constant for each of the five plots. Such examination also shows that the variation in relative standing of the plots where each of the different potash salts was used is fairly constant for each. The most marked exception to this rule is found in the case of plots 30, 36 and 37, where the yields are lower than on other plots receiving the same potash salts. This inferiority on these plots appears to have been due to the fact that the stand of plants in them was too thin. A count indicates that the average number of plants in a row in this field is about 120; in Plot 30 it was about 95; in plots 36 and 37 about 45. The potash salt giving the highest yield in this experiment is the carbonate, followed closely by the high-grade sulfate and silicate. The potash salts, other than kainite, containing chlorine (low-grade sulfate and muriate), give yields considerably lower. As neither the carbonate nor the silicate of potash is commonly found in our markets, these having been manufactured in the first instance as fertilizers for tobacco, the practical lesson to be drawn from the experiment is that for the soy bean it is much safer to depend upon the high-grade sulfate as a source of the needed potash than to use any of the potash salts containing chlorine. Neither the carbonate nor the silicate, even if available, would be preferable to the high-grade sulfate, as the cost per unit of potash is much greater than with sulfate. The result of the past season is in agreement with results obtained with this crop in a considerable number of earlier experiments, and it seems impossible to doubt the validity of the conclusion above stated. The advice, therefore, is most strongly given, that, on all soils at least with good retentive qualities and moisture, the sulfate of potash should generally be preferred to muriate or kainite, not only for soy beans, but for clovers and with little doubt for all other legumes as well.

IV. — Special Fertilizer v. Fertilizer Richer in Potash.

This experiment has been in progress since 1891. It occupies an acre of ground, divided into four equal plots. The crop from 1891 to 1896, inclusive, was corn; in 1897 and 1898 the crop was mixed grass and clover; in 1899 and 1900 it was corn; in 1901 and 1902, grass and clover; in 1903 and 1904, corn. The land was seeded in the corn in late summer, 1904. The crop harvested this year is hay, — mixed timothy, red-top and clover. The object in this experiment is to test the question whether the special corn fertilizers offered in our markets are of such composition as is best suited for the production in rotation of corn and mixed hay. The plots are numbered from 1 to 4. Plots 1 and 3 yearly receive an application of fertilizers furnishing the same amount of nitrogen, phosphoric acid and potash as would be furnished by 1,800 pounds of fertilizer of the composition of the average of the special corn fertilizers analyzed at this station. This average has changed but little during recent years, and in 1899, since which date we have made no change in the kinds and amounts of fertilizers used, was as follows: —

	Per Cent.
Nitrogen,	2.37
Phosphoric acid,	10.00
Potash,	4.30

The fertilizers used on plots 2 and 4 are substantially the same in amount and kind as recommended in Bulletin No. 58 of this station for corn on soils poor in organic matter. The essential difference in composition between the fertilizer mixtures under comparison is that the mixture used on plots 2 and 4 is richer in potash and much poorer in phosphoric acid than the mixture representing the average market corn fertilizers. The fertilizers applied to the several plots are shown below: —

Fertilizers used.	Plots 1 and 3 (Pounds Each).	Plots 2 and 4 (Pounds Each).
Nitrate of soda,	30.0	50.0
Dried blood,	30.0	-
Dry ground fish,	37.5	50.0
Acid phosphate,	273.0	50.0
Muriate of potash,	37.5	62.5

The following tables show rates of yields per acre of both hay and rowen on the several plots, and the averages for the two systems of manuring: —

Yields per Acre (Pounds).

Plots.	Hay.	Rowen.
Plot 1 (lesser potash),	3,960	240
Plot 2 (richer in potash),	3,900	360
Plot 3 (lesser potash),	3,720	400
Plot 4 (richer in potash),	3,720	300

Average Yields per Acre (Pounds).

Plots.	Hay.	Rowen.
Plot 1 and 3 (lesser potash),	3,840	320
Plots 2 and 4 (richer in potash),	3,810	330

It will be noticed that the yields under the two systems of manuring, both in hay and rowen, are substantially equal. At current prices, the cost per acre of the fertilizers used on plots 2 and 4 is about $5 less than the cost of the materials used on plots 1 and 3. As we have secured equal crops at a materially lower price, the advantage is clearly with the fertilizer combination richer in potash.

V. — Manure alone *v.* Manure and Potash.

By way of description of this experiment, I cannot do better than to quote from the seventeenth annual report: —

These experiments, which have for their object to show the relative value as indicated by crop production of an average application of manure used alone, as compared with a smaller application of manure used in connection with a potash salt, were begun in 1890. The field used is level, and the soil of comparatively even quality. It is divided into four quarter-acre plots. The crop grown during the years 1890 to 1896, 1899 and 1900, 1903 and 1904, has been corn. In 1897 and 1898, and again in 1901 and 1902, the crop was mixed grass and clover. Where manure is used alone, it is applied at the rate of 6 cords per acre. Where manure is used with potash, the rates of application are: manure, 4 cords; high-grade sulfate of potash, 160 pounds per acre. Manure alone is applied to plots 1 and 3; the lesser quantity of manure and high-grade sulfate of potash to plots 2 and 4. Estimating the manure alone as costing $5 per cord, applied to the land, the money difference in the cost of the materials applied is at the rate of $6.40 per acre, the manure and potash costing that amount less than the larger quantity of manure alone.

Mixed timothy, red-top and clover was sown in late summer in the standing corn of last year. The following tables show the rates of yield on the several plots and the averages under the two systems of manuring: —

Yields per Acre, 1905 (Pounds).

Plots.	Hay.	Rowen.
Plot 1 (manure alone), ...	6,720	1,840
Plot 2 (manure and potash), ...	5,820	1,200
Plot 3 (manure alone), ...	6,120	1,720
Plot 4 (manure and potash), ...	8,580	1,640

Average Yields per Acre (Pounds).

Plots.	Hay.	Rowen.
Plots 1 and 3 (manure alone), ...	6,420	1,780
Plots 2 and 4 (manure and potash), ...	7,200	1,420

It will be noticed that the average yield on the two plots receiving the smaller quantity of manure and potash is somewhat greater than on the other two plots. Since this combination (4 cords of manure and 160 pounds muriate of potash) costs $6.40 per acre less than the 6 cords of manure, the advantage is decisively in favor of the combination.

VI. — Experiment in the Application of Manure.

This experiment was begun in 1899, and is to be continued for a series of years. It is designed to throw light upon the question as to whether it is economically good policy to spread manure during the late fall and winter and allow it to remain on the surface until spring before plowing under. This method of application is compared with the plan of hauling manure from the stable to the field during the winter and putting it into large compact heaps, from which it is hauled and spread just before plowing in spring. The field in which this experiment is tried slopes moderately to the west. In further description I quote from the seventeenth annual report: —

To insure even quality of the manure used in the two systems, it is our practice to manure two plots at one time, putting the loads of manure as hauled to the field alternately upon the two, in the one case spreading, but in the other putting a sufficient number of loads to provide for the entire plot into one large heap. We are using in this experiment five large plots, each of which is subdivided into two subplots. For one of these subplots the manure is spread when hauled out, for the other it is put into a large heap. The area of these subplots is about one-quarter of an acre, and to each the amount of manure applied is 11,096 pounds. The manure from well-fed milch cows is used upon eight subplots, and horse manure on two. The manure used in this experiment is applied at different dates during the winter, our practice being to allow the manure to accumulate in the pits from which it is taken until there is a sufficient quantity for at least two subplots. The condition of the soil at the time of application and the nature of the weather which follows must necessarily differ in the different experiments; and these differences, together with the difference in the dates of application above referred to, no doubt in a measure account for the variation in the results of the two systems noticed on the different plots.

The crop raised in this field last year was mixed corn and soy beans for ensilage. After the harvest of this crop the field was well harrowed and sown to rye. This crop, which was intended for cover, germinated but poorly and made only a feeble growth. The crop of 1905 was corn, — a number of different varieties received for comparison from the United States Department of Agriculture, and Sibley's Pride of the North of our own growing. These varieties were so arranged that each plot and subplot had equal areas of each. The soil was thoroughly prepared by plowing and harrowing, and the seed was sown on May 19. Soil and seasonal conditions were favorable, and the growth was uninfluenced, so far as could be recognized, by accidental conditions. A number of varieties sown showed relatively low productive capacity, and the final yield was lower than is usual in this section on well-manured land of similar quality. The rates of yield per acre and the relative standing of the several plots are shown in the following tables : —

Corn and Stover. — Actual Yields (Rates per Acre).

Plots.	North Half, Winter Application.			South Half, Spring Application.		
	Stover (Pounds).	Hard Corn (Bushels).	Soft Corn (Bushels).	Stover (Pounds).	Hard Corn (Bushels).	Soft Corn (Bushels).
1,	7,347	31.51	3.21	7,862	32.16	2.45
2,	7,150	25.96	2.99	7,763	32.08	4.00
3,	6,806	22.13	4.36	7,713	27.25	3.53
4,	7,447	24.44	3.06	8,309	29.20	2.85
5,	7,637	30.46	2.34	8,026	32.48	2.31

Corn and Stover. — Relative Yields (Per Cent.).

Plots.	North Half, Winter Application.		South Half, Spring Application.	
	Stover.	Hard Corn.	Stover.	Hard Corn.
1,	100	100	107.0	102.1
2,	100	100	108.6	123.6
3,	100	100	113.3	123.1
4,	100	100	111.6	119.5
5,	100	100	105.1	106.4

It will be noticed that in every instance spring manuring has given a larger yield both of stover and of hard corn than winter application. This result is in general agreement with those of earlier years, but the differences as indicated by the relative yields are comparatively small. The winter of 1904 and 1905 was characterized by uniform temperatures, fairly deep and continuous snow cover and absence of thaws. Such conditions are of course favorable to winter application, and the above-mentioned peculiarities of season perhaps account for the smaller relative differences in yield this year.

The system of manuring designated as spring application involves, as will have been noticed by the reader, twice handling, while in winter application the manure is handled but once. Spring application, therefore, costs more than winter application. As the result of our experience, we estimate the money difference to amount to $4.80 per acre. The average difference in the value of crops this year in favor of spring application, estimating stover to be worth $5 per ton and the corn as husked 50 cents per bushel, amounts to only $3.49 per acre, — a sum insufficient to cover the increased cost of spring application. Even on Plot 3, where the difference in favor of spring application is greatest, the money difference in value of the crops on the same basis as before is only $4.81, which barely covers the increased cost of application. The results for this season, therefore, economically considered, indicate that spreading the manure as taken from the stable in the fall or winter is to be preferred.

VII. — Experiment in manuring Grass Land.

The plan of this experiment, which has continued now for thirteen years, will be made clear by quoting from the sixteenth annual report: —

In this experiment, which has continued since 1893, the purpose is to test a system of using manures in rotation for the production of grass. The area used in the experiment is about 9 acres. It is divided into three approximately equal plots. The plan is to apply to each plot one year barnyard manure, the next year wood ashes, and the third year fine-ground bone and muriate of potash. As we have three plots, the system of manuring has been so arranged that every year we have a plot illustrating the results of each of the applications under trial. The rates at which the several manures are employed are as follows: barnyard manure, 8 tons; wood ashes, 1 ton; ground bone, 600 pounds; and muriate of potash, 200 pounds, per acre. The manure is always applied in the fall; ashes and the bone and potash in early spring.

The past season has been rather unfavorable for the production of large yields of hay, as there was a considerable deficiency in both spring and summer rainfall. The yields of hay and rowen and the total yields for each system of manuring were at the following rates per acre: —

Fertilizers used.	Hay (Pounds).	Rowen (Pounds).	Totals (Pounds).
Barnyard manure,	3,738	1,210	4,948
Bone and potash,	3,326	1,249	4,575
Wood ashes,	3,816	1,047	4,863

The average yield of the entire area this year was 4,840 pounds per acre. The average yield of the entire area from 1893 to 1904, inclusive, has been 6,718 pounds per acre. The average yield from 1893 to 1905, inclusive, has been 6,479 pounds per acre. The average yields under the different systems of top-dressing have been as follows: —

	Pounds per Acre.
When top-dressed with manure,	6,866
When top-dressed with wood ashes,	6,193
When top-dressed with bone and potash,	6,524

It will be noticed that the average yields of the entire area for this year are much below similar averages for the period.

VIII. — Nitrate of Soda for Rowen.

For the past five years we have been experimenting in one of our fields for the purpose of determining whether nitrate of soda applied soon after the first crop is cut will give a profitable increase in the rowen crop. The field where this experiment has been tried was seeded to pure timothy in the fall of 1897. The growth is now considerably mixed with clover, which has been gradually coming in. The whole field is uniformly fertilized for the first crop. The materials applied are usually put on in early spring at the following rates per acre: nitrate of soda, 150 pounds; muriate of potash, 200 pounds: fine-ground bone, 400 pounds. This application usually gives us a good crop. The area of the field is a little more than 3 acres. The rate of yield in the first crop this year was 4,471 pounds of well-cured hay per acre. In this field eight equal plots, containing almost exactly 1/3 acre each, have been laid out. Alternate plots in the series of eight receive annually a top-dressing of nitrate of soda. For the past two years, in order that the nitrate may be more uniformly spread, we have mixed the quantity to be applied to each plot with sufficient basic slag meal to constitute an application at the rate of 400 pounds per acre. To equalize conditions on the alternate plots to which no nitrate is applied, the basic slag meal is applied to all of these at the same rate. The rates of application for the fertilizers on the several plots per acre and the yields are shown in the table: —

Nitrate of Soda for Rowen.

Plots.	Fertilizers used (Rates per Acre).	Yield (Pounds).	Increase per Acre (Pounds).
1, . .	Slag meal, 400 pounds, ...	975	–
2, . .	Slag meal, 400 pounds; nitrate of soda, 150 pounds.	1,127	228
3, . .	Slag meal, 400 pounds, ...	822	–
4, . .	Slag meal, 400 pounds; nitrate of soda, 150 pounds.	1,036	305
5, . .	Slag meal, 400 pounds, ...	640	–
6, . .	Slag meal, 400 pounds; nitrate of soda, 200 pounds.	1,340	486
7, . .	Slag meal, 400 pounds, ...	1,067	–
8, . .	Slag meal, 400 pounds; nitrate of soda, 250 pounds.	3,009	1,942

It will be noticed that the nitrate of soda wherever applied has given an increase in the crop. This increase is relatively small in all the plots except Plot 8, where it is at the rate of nearly 1 ton per acre. During all the years that this experiment has been tried on this land it has been found that the yield on Plot 8 has been much the largest in the fall. True, this receives the heaviest application of nitrate, but it is not believed that the superiority in yield is entirely due to this difference. The moisture conditions are more favorable to growth during the late summer in this plot than in the others. During the five years that this experiment in the use of nitrate of soda for the rowen crop has been tried on this field, it has seemed to give increases sufficient to make the application profitable only in two trials; and, on the whole, the results of our experiments are not favorable to the conclusion that it will usually be found profitable to use nitrate of soda for the rowen crop. The soil in this field is a strong and retentive loam. It is, of course, quite possible that on soils of different character the results of the use of nitrate for rowen will be more favorable.

IX. — Fertilizers for Garden Crops. (Field C.)

In this experiment the principal object in view is to study the effect of some of the standard fertilizing materials upon the yield and quality of garden crops. During the earlier years of the experiment, 1891 to 1897 inclusive, fertilizers alone were applied to the land. It was then decided that, since market gardeners as a rule employ large quantities of manure, the value of the experiment to those engaged in that branch of agriculture would be increased by applying manure equally to all the plots, while still continuing the application of fertilizers. During the earlier years of the experiment there were but six plots, on all of which fertilizers were used. With the change in system alluded to a seventh plot was introduced, and to all of the seven plots stable manure at the rate of 30 tons per acre has since been annually applied. It is intended that the seventh plot, on which manure alone is applied, shall serve as a basis of comparison with the others, in order that we may learn whether, and, if so, to what extent, any fertilizers prove beneficial. The seventh plot immediately adjoins the others, but previous to its inclusion in this experiment it had been manured somewhat differently. For the first few years the product on manure alone on this plot exceeded the product with equal manure and fertilizers on the other plots. This initial superiority is gradually disappearing, and the product of most of the crops where the fertilizers as well as manure are used now exceeds that upon the seventh plot, where manure only is used. It is possible that the seventh plot does not even yet serve as a fair basis for comparison; but the following crops on most of the plots, where fertilizers in addition to manure are used, have given yields sufficiently greater than those produced where manure alone is used to much more than pay for the cost of the fertilizers, viz.: asparagus, rhubarb, peas, squashes, tomatoes and table beets. It should be pointed out, however, that such increase was in most cases very small where sulfate of ammonia is one of the fertilizer materials used. Indeed, with asparagus the combination of manure and fertilizers containing sulfate of ammonia gave a smaller yield than manure alone. With tomatoes the increased yield was mainly confined to green fruit. The fertilizers did not materially increase the yield of ripe fruit as compared with the yield obtained on manure alone. Some crops showed no increase at all on the plots where fertilizers were added to the manure. Among these were celery and turnips, while cabbages gave either no increase at all or one which was insignificant.

Practically all important out-door garden crops have been grown in rotation upon each plot, and each crop during several years. The crops so far grown are as follows: spinach, lettuce, onions, garden peas, table beets, early and late cabbages, potatoes, tomatoes, squashes, cucumbers, turnips, sweet corn, celery and strawberries. One row each of asparagus and rhubarb was set in each plot in 1902. The first cuttings were made last year.

As stated in my last annual report, these "experiments have been planned with reference to throwing light especially upon two points: *A*. The relative value of nitrate of soda, sulfate of ammonia, and dried blood used as sources of nitrogen. *B*. The relative value of sulfate of potash and muriate of potash. These two points will be separately discussed."

A. — The Relative Value of Nitrate of Soda, Sulfate of Ammonia and Dried Blood as Sources of Nitrogen.

The three fertilizers under consideration have from the first been applied in such amounts as to furnish nitrogen at the rate of 60 pounds per acre to each plot. Each fertilizer is always applied to the same plot. To furnish 60 pounds of nitrogen, the application of the fertilizers at about the following rates per acre is required: —

	Pounds.
Nitrate of soda,	375
Sulfate of ammonia,	300
Dried blood,	650

Each of these fertilizers is used on two plots, on one of which the source of the potash is the sulfate, on the other the muriate, in both cases in such quantities as to furnish equal actual potash. In addition to the nitrogen and potash fertilizers, dissolved boneblack is applied at the rate of 320 pounds per acre to all plots. The amount of actual potash applied is at the rate of 120 pounds per acre; the amount of actual phosphoric acid at the rate of 50.4 pounds per acre. The source of the potash used affects the results on some of the crops in a marked degree. This is especially the case where sulfate of ammonia is the source of nitrogen.

The results obtained previous to this year may be summarized as follows: —

For the early crops, *i.e.*, the crops making most of their growth before mid-summer, including onions, lettuce, table beets, garden peas, spinach, early cabbages and strawberries, the nitrate of soda has been found the most effective source of nitrogen.[1]

The relative standing of the different nitrogen fertilizers, as measured by the total yields, including leaves, vines and tops, as well as the marketable product, is as follows for the early crops: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	95.64
Sulfate of ammonia,	60.95

[1] Sixteenth annual report, Hatch Experiment Station, p. 124.

For the late crops, including late cabbages, celery, tomatoes, turnips and squashes: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	98.88
Sulfate of ammonia,	78.74

The relative average standing of the sulfate and muriate of potash, as indicated by the total yield of all crops grown in Field C previous to this year, is shown in the following table: —

Fertilizers used.	Early Crops (Per Cent.).	Late Crops (Per Cent.).
Sulfate of potash,	100.00	98.32
Muriate of potash,	94.04	100.00

For the past year the relative standing of the nitrogen fertilizers for the early crops, including asparagus, rhubarb, strawberries, peas and table beets, is as follows: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	96.11
Sulfate of ammonia,	92.83

For the late crops, including cabbages, celery, tomatoes, turnips and squashes, the relative standing is: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	97.22
Sulfate of ammonia,	90.51

Combining the results for 1905 with the fourteen previous years, the relative standing of the nitrogen fertilizers is: —

For the early crops: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	95.67
Sulfate of ammonia,	63.08

For the late crops: —

	Per Cent.
Nitrate of soda,	100.00
Dried blood,	98.77
Sulfate of ammonia,	79.52

The relative standing of the potash salts for the present year is: —

For the early crops: —

	Per Cent.
Sulfate of potash,	96.52
Muriate of potash,	100.00

For the late crops: —

	Per Cent.
Sulfate of potash,	92.08
Muriate of potash,	100.00

Combining the relative standing of the potash salts for 1905 with the figures indicating relative standing for the fourteen previous years, the relative standing is: —

For the early crops: —

	Per Cent.
Sulfate of potash,	100.00
Muriate of potash,	94.66

For the late crops: —

	Per Cent.
Sulfate of potash,	97.90
Muriate of potash,	100.00

The results of the experiments for this year will not be reported in detail. The following points are worthy of mention: —

1. Nitrate of soda appears to be the best source of nitrogen for asparagus, table beets, cabbages and squashes.

2. Dried blood as the source of nitrogen has given the largest crops in the case of strawberries, peas, tomatoes and celery.

3. Sulfate of potash as the source of potash seems to be superior for asparagus, peas, beets and cabbages.

4. Muriate of potash gives results superior to those obtained with the sulfate for rhubarb, strawberries, squashes, tomatoes and celery.

5. Sulfate of ammonia for practically all crops appears to have been the poorest material used as a source of nitrogen.

X. — Alfalfa.

Our experiments with alfalfa have been continued both upon our own grounds and those of a few selected farms in different parts of the State. We are bringing to bear upon these experiments information in regard to successful methods from every possible source. We find in all cases a distinct benefit from a heavy initial application of lime. We have used from 2,000 to 3,000 pounds per acre. We are enriching soils already naturally good by heavy applications both of manures and fertilizers, using materials which experience has proved best. We are also giving the soil a most thorough preparatory tillage. It has usually been fall-plowed, and in addition it is plowed in the spring, and repeatedly harrowed to destroy weeds which start in the early part of the season. We have tried inoculating the soil both with earth obtained from a field in New York, where alfalfa is successfully grown, and with the cultures sent out by the Department of Agriculture and prepared by private firms. We have not attained such degree of success as justifies us in recommending the crop. We have occasionally got a fair stand of alfalfa, but in all cases the winters prove more or less injurious. In the course of a few years the alfalfa is mostly crowded out by grasses and clovers. The alfalfa almost every year suffers from leaf spot, which tends to cut down the yield.

We have found a very distinct benefit from the inoculation with earth from the New York alfalfa field. We have not found an equally distinct benefit to follow inoculation with any of the cultures; and, although we are not as yet ready to make a final report, it should be here remarked that the most careful experiments on the use of these cultures in sterilized soils, under conditions calculated to give accurate results, indicate that they have little if any value.

In our various experiments alfalfa has been tried on a wide variety of soils. We have had a quarter of an acre field upon a coarse-textured soil upon a farm in this neighborhood where there is never any standing water within 50 to 60 feet of the surface. Even on this soil the alfalfa, although it did fairly well for a year, has been injured by successive winters, until it is at the present time almost ruined.

In this connection I call attention further to the fact that Mr. D. S. Bliss of the Department of Agriculture, who has been making special efforts to promote the introduction of alfalfa into New England, and who has travelled extensively for the purpose of studying the results obtained, now speaks very discouragingly as to the outlook in general.

In conclusion, while we are not inclined to discourage experiments with alfalfa, we do wish most emphatically to caution against engaging in these experiments upon an extended scale, for we feel that disappointment is almost inevitable.

XI. — Poultry Experiments.

Our work with poultry during the past year has had the same general purpose in view as in former years, namely, to throw light on the question of the proper selection of feeds for laying fowls. The fowls used in the experiments were pullets of our own raising, and matched flocks have been kept, as in former years, each in a house by itself, all the houses being of precisely similar dimensions and construction.

1. The two flocks in houses Nos. 1 and 2 have been fed on rations characterized by high content both of ash and fat and low fiber. The deficiency of wheat in fat as compared with corn is made up in the ration fed to the fowls in House No. 1 by the use of corn oil, the total amount of fat in the foods used being substantially the same for the two rations. This experiment, therefore, in a general way affords opportunity to test the relative value for egg production of wheat and corn. The ration fed the fowls in House No. 1 contains a relatively high percentage of protein, and has a narrow nutritive ratio. The ration used in House No. 2 contains a relatively low percentage of protein, and has a wide nutritive ratio. The animal food used in both these rations was beef scraps. The following results were obtained: for the first period, March 2 to May 12, inclusive, the wheat ration produced eggs at the average rate of .39 per hen day, the

corn ration at the rate of .45 per hen day; in other words, 100 hens would have laid 39 eggs per day on the wheat ration and 45 eggs per day on the corn ration. For the second period, May 13 to September 23, inclusive, the wheat ration produced an average of .31 eggs per hen day, the corn ration at the rate of .41 eggs per hen day; in other words, during the summer period 100 hens would have laid 31 eggs per day on the wheat ration and 41 eggs per day on the corn ration. The average food cost per egg produced was: for the wheat ration 1.036 cents, for the corn ration .749 cents, for the first period; while for the second period the cost per egg on the wheat ration was .895 cents and for the corn ration .703. The gross cost of the food on the wheat ration varied from about .26 cents to .37 cents per day for each fowl; while on the corn ration the cost varied from .27 cents to .30 cents per day. The number of eggs on the corn ration was considerably greater than on the other, and the cost per egg was much smaller. This result is in agreement with the results of most of the similar experiments which we have tried in earlier years. We are certainly justified in the conclusion that corn has superior merits for egg production as compared with wheat.

2. The rations fed to the fowls in pens Nos. 3 and 4 were characterized by relatively high ash and low fiber content. Milk albumen was used as the source of animal food on account of the low percentage of fat it contains; and the rations fed to the fowls in both of these pens were characterized by much lower fat content than the rations fed to the fowls in pens Nos. 1 and 2. As in the first set of comparisons, the fat content of the two rations used in pens Nos. 3 and 4 was equalized by the addition of corn oil to the one naturally lower in fat. In this experiment, as in the first, wheat was the leading whole grain in the ration fed to the fowls in one house (No. 3); corn the leading whole grain used in the other house (No. 4). The results with the fowls in these houses, like the results obtained in houses Nos. 1 and 2, afford a basis for estimating the relative value of wheat and corn, but with a relatively low percentage of fat in both. The egg product in this experiment was as fol-

lows: for the first period, March 3 to May 12, inclusive, the wheat ration produced eggs at the average rate of .41 per hen day, the corn ration .39 per hen day; or, in other words, 100 hens would have laid on the wheat ration 41 eggs, on the corn ration 39 eggs, per day. For the second period, May 13 to September 23, inclusive, the wheat ration gave an average of .35 eggs per hen day, the corn ration .31; or, in other words, respectively for the wheat ration, an average of 35 eggs per hundred hens daily, and for the corn an average of 31 eggs. The food cost of the eggs in this experiment was as follows: for the wheat ration during the summer period, .845 cents per egg; for the spring period, 1 cent per egg. For the corn ration, the food cost per egg was .871 cents for the summer period; .942 cents for the spring period. The cost of food per hen daily on the wheat ration varied from .273 to .372 cents; for the corn ration, from .248 to .333 cents. In this experiment the wheat ration gave a somewhat better egg yield than corn, but at a higher average cost per egg. The experiment indicates, therefore, that, unless the fat content of the ration is relatively high, the more starchy foods are not sufficient to produce a satisfactory egg yield, and the product falls below that obtained from feeding a ration higher in protein.

3. The fowls in houses Nos. 5 and 6 were fed rations in both cases characterized by low protein, high ash and high fat content, the deficiency of fat in the grains selected being made up by the use of corn oil. The fowls in Pen No. 5 were fed grains, including oats and oat feed, characterized by a high proportion of fiber. Those in Pen No. 6 were fed grains among which rice was prominent, characterized by a low percentage of fiber. The experiment in these houses, then, was calculated to throw light upon the influence of fiber on egg production, the nutritive ratio in the two houses being substantially the same, — about 1 to 6.5. In these houses beef scraps was the animal food used. The results were as follows: For the period March 2 to May 12, inclusive, the egg production was: for the oat ration (high fiber) .40 eggs per hen day, for the rice ration (low fiber) .42 eggs per hen day; or, in other words, from 100 hens

daily respectively 40 and 42 eggs. For the second period, May 13 to September 23, inclusive, the averages were: on the oat ration .38 eggs per hen day, on the rice ration .46 eggs per hen day; or, from 100 hens daily respectively 38 and 46 eggs. The food cost of the eggs has been as follows: for the oat ration during the first period 1.019 cents, for the second period .935 cents; for the rice ration for the first period 1.103 cents, for the second period 1.048 cents. The cost of food per hen per day has varied for the oat ration from .32 to .40 cents; for the rice ration from .412 cents to .423 cents per day. The rice ration, as last year, has given a very satisfactory yield of eggs, but, as was then stated, its high price at the present time renders it poor economy to use it. We are employing it in these experiments because it contains less fiber than any other grain, and we are trying to throw light upon the influence of fiber in egg production. The indication this year, as last, is very clear that this influence is unfavorable.

The nutritive ratios in the food combinations used in the different experiments of the past year have been as follows: for the rations where wheat is compared with corn with beef scraps for animal food and high fat content, — for the wheat ration, between 1 to 4.57 and 4.26; for the corn ration, between 1 to 6.69 and 5.81; for the experiment in which wheat is compared with corn with milk albumen and beef scraps for animal food, — for the wheat ration, between 1 to 4.03 and 4.54; for the corn ration, 1 to 6.28 and 5.84; in the experiment in which oats and rice have been compared with high fat content, — for the oats, between 1 to 5.88 and 6.49; for the rice, between 1 to 5.84 and 6.53.

Our experiments clearly do not support the view that a narrow nutritive ratio is essential to good egg production.

REPORT OF THE HORTICULTURIST.

F. A. WAUGH.

The work of the division of horticulture for the past year has followed the lines announced in previous reports. It has been concerned chiefly with the propagation of plants, more especially dwarf fruit trees, with problems in pruning, and with the systematic study of varieties. During the year some interesting experiments in the growing of mushrooms have been under way. There follows herewith a report of progress in the experiments in pruning peach trees of bearing age.

Pruning Peach Trees.

A year ago this department made a report on experiments in pruning peach trees.[1] Another year has thrown new evidence on the problems involved, so it seems best to take up the subject again. In the mean time the trees have borne a considerable crop of fruit, and their behavior under this load has been particularly interesting.

Last year's report dealt with various problems, one of which was the practice of pruning frozen peach trees to help their recovery. Briefly stated, the experiment comprised four methods of treatment, as follows: (*a*) no pruning; (*b*) moderate pruning; (*c*) severe heading back: (*d*) cutting back to stubs, or "dehorning." The results of these various methods of pruning, as developed up to the time of making last year's report (December, 1904), showed that moderate pruning was to be preferred. It may be said at once that this general conclusion stands without much modification, though the severely pruned trees made a relatively better showing under the stress of a good crop of fruit.

[1] Hatch Experiment Station, seventeenth annual report, p. 162 (1905).

Perhaps the fact most obviously developed by the year's experience is that the trees were more severely injured by the freezes of 1902–03 and 1903–04 than had been supposed. From week to week one tree after another broke down or split down or lost large branches, through the stress of winds or growing fruit crop. As each successive tree broke down, it was plainly to be seen that the wood had been seriously injured by freezing, and that it had not recovered. Though the tree kept on growing, adding fresh and healthy outer layers of wood, the interior was dead and decaying. In many cases this decay was serious, and had extended through considerable areas of tissue. Many fungi (mostly saprophytes such as feed on dead wood) had gained a foothold, and seemed to be out-thriving the peach trees.

These evidences of decay, especially the larger fungi (polypori, etc.), were most conspicuous on the "dehorned" trees. A few of these trees have finally succumbed during the summer of 1905, and it is now plainer than it was a year ago that this method of treating severely frozen peach trees is not to be recommended. An additional drawback lay in the fact that the trees bore little or no fruit in 1905, while all the other trees in the experiment bore a good crop.

Perhaps a word of explanation should be added to this statement of the case. This method of pruning peach trees back to mere stubs has its uses, as in renewing the head when a tree is to be rebudded to a new variety. It can be successfully carried out, but only on vigorous and comparatively young trees. Trees weakened by freezing are precisely the ones which cannot respond to such vigorous treatment.

Coming next to the trees severely headed back (from which practically all the one-year-old wood was removed in the spring of 1905), we find conditions much better. There are some manifest evidences of the injury received during the freezes of two and three winters ago, some broken limbs and some growth of saprophytic fungi; but the trees show strong, sturdy tops, with a very satisfactory annual growth for 1905. The trees bore a good crop of fruit in 1905, and are in the best condition of any in the orchard for carrying another crop in 1906. While trees severely headed back recovered less readily from the effects of freezing, those which finally bore the crop made distinctly better growth for the pruning.

The trees lightly pruned were cut back only a part of the previous year's annual growth, — from one-third to one-half. The largest percentage of recovery was shown by these trees, and they bore slightly larger crops of fruit in 1905 than any of the others. On the other hand, there appeared to be more breakage of large branches, the heads are left in less satisfactory form than on trees severely headed back, and the prospect for carrying a good crop in 1906 seems to be slightly less.

The trees left without pruning are now distinctly the poorest in the orchard, with the exception only of those that were "dehorned." The percentage of loss was high, the crop of 1905 was inferior to that on the pruned trees, and the present condition of these trees is unsatisfactory.

As the result of this experiment, the following practice would seem to be indicated: —

1. Prune peach trees moderately, removing not more than one-third to one-half the previous year's annual growth, when the wood has been injured by freezing.

2. When only the fruit buds are killed, the wood being uninjured and the trees in good condition, prune severely, cutting back the annual growth to two or three buds. It may be expedient to cut some branches back even into two or three year old wood.

REPORT OF THE CHEMIST.

DIVISION OF FERTILIZERS AND FERTILIZER MATERIALS.[1]

CHARLES A. GOESSMANN.

Assistants: HENRI D. HASKINS, EDWARD G. PROULX, E. T. LADD.

PART I. — Report on Official Inspection of Commercial Fertilizers.

PART II. — Report on General Work in the Chemical Laboratory.

PART I. — REPORT ON OFFICIAL INSPECTION OF COMMERCIAL FERTILIZERS AND AGRICULTURAL CHEMICALS DURING THE SEASON OF 1905.

CHARLES A. GOESSMANN.

The total number of manufacturers, importers and dealers in commercial fertilizers and agricultural chemicals who have secured licenses during the past season is 64; of these, 36 have offices for the general distribution of their goods in Massachusetts, 9 in New York, 6 in Connecticut, 3 in Vermont, 2 in Ohio, 1 in Rhode Island, 1 in Maryland, 1 in Tennessee, 1 in Arkansas, 1 in Missouri, 1 in Canada, 1 in New Jersey and 1 in Pennsylvania.

[1] See also tables in Appendix.

Three hundred and twenty-six brands of fertilizers and agricultural chemicals have been licensed in Massachusetts during the year. Five hundred and seventy-four samples of fertilizers have been collected up to the present time, in our general markets, by experienced assistants in the station. Five hundred and eleven samples had been analyzed at the beginning of December, 1905, representing 313 distinct brands of fertilizers. These analyses were published in two bulletins of the Hatch Experiment Station of the Massachusetts Agricultural College: No. 104, July; No. 107, November, 1905. The analyses of other officially collected samples of fertilizers not included in these two bulletins will be published in our next bulletin, in March, 1906. About the same number of fertilizers were licensed in Massachusetts during the year as in 1904. The results of our inspection work show 18 more samples analyzed during the season than for the previous year.

The following table gives a brief abstract of the results of analyses of the official commercial fertilizers in comparison with the year previous: —

	1904.	1905.
(*a*) Where three essential elements of plant food were guaranteed: —		
Number with three elements equal to or above the highest guarantee, .	7	3
Number with two elements above the highest guarantee, . . .	32	16
Number with one element above the highest guarantee, ...	111	83
Number with three elements between the lowest and highest guarantee,	190	203
Number with two elements between the lowest and highest guarantee,	146	138
Number with one element between the lowest and highest guarantee, .	48	38
Number with three elements below the lowest guarantee, . . .	none	1
Number with two elements below the lowest guarantee, ...	12	25
Number with one element below the lowest guarantee, ...	103	92
(*b*) Where two essential elements of plant food were guaranteed: —		
Number with two elements above the highest guarantee, . . .	8	3
Number with one element above the highest guarantee, ...	16	29
Number with two elements between the lowest and highest guarantee,	20	13
Number with one element between the lowest and highest guarantee, .	19	23
Number with two elements below the lowest guarantee, ...	1	5
Number with one element below the lowest guarantee, ...	15	21
(*c*) Where one essential element of plant food was guaranteed: —		
Number above the highest guarantee, ...	16	4
Number between the lowest and highest guarantee, ...	24	25
Number below the lowest guarantee, ...	13	19

From the above table it will be seen that the quality of the licensed fertilizers during the past year has not been up to the usual standard.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1904 and 1905 (Cents per Pound).

	1904.	1905.
Nitrogen in ammonia salts,	17.50	17.50
Nitrogen in nitrates,	16.00	17.00
Organic nitrogen in dry and fine-ground fish, meat, blood, and in high-grade mixed fertilizers,	17.50	18.50
Organic nitrogen in fine bone and tankage,	17.00	18.00
Organic nitrogen in coarse bone and tankage,	12.50	13.00
Phosphoric acid soluble in water,	4.50	4.50
Phosphoric acid soluble in ammonium citrate,	4.00	4.00
Phosphoric acid in fine ground fish, bone and tankage,	4.00	4.00
Phosphoric acid in cotton-seed meal, castor pomace and wood ashes,	4.00	4.00
Phosphoric acid in coarse fish, bone and tankage,	3.00	3.00
Phosphoric acid insoluble (in water and in neutral citrate of ammonia) in mixed fertilizers,	2.00	2.00
Potash as sulfate, free from chlorides,	5.00	5.00
Potash as muriate (chloride),	4.25	4.25
Potash as carbonate,	–	8.00

A comparison of the market cost of the three essential elements of plant food for 1905 with the previous year shows the only variation to be in the various forms of nitrogen compounds: nitrogen in the form of nitrates, and the higher grades of organic nitrogen, including nitrogen in high-grade mixed fertilizers, is a cent higher per pound; while the medium and lower grades of organic nitrogen also show an increased cost of one-half cent per pound. All nitrogen compounds, with the exception of ammoniates, show somewhat of an increase in cost as compared with 1904.

The above schedule of trade values was adopted by representatives of the Massachusetts, Connecticut, Rhode Island, Maine, Vermont and New Jersey experiment stations at a conference held during the month of March, 1905, and is based upon quotations in the fertilizer market in centers of distribution in New England, New York and New Jersey during the six months preceding March, 1905, and refers to the current market prices, in ton lots, of the leading standard raw materials furnishing nitrogen, phosphoric acid and potassium oxide, and which go to make up our commercial fertilizers.

Table A, on the following page, gives the average composition of licensed fertilizers for 1905; Table B gives a compilation of analyses showing the average percentages, as well as the maximum and minimum percentages, of the three essential elements of plant food found in the so-called special crop fertilizers put out by the different manufacturers. This latter table shows how unsafe it is to be guided wholly by trade name when selecting a fertilizer for any special crop. Out of the several hundred fertilizers that are annually offered for sale in the general markets in Massachusetts, it becomes no easy matter for the farmer to select to meet his requirements in cases of the ready factory-mixed goods. No infallible rule can be laid down, as soil conditions vary so widely, and so much depends upon crop rotation. It is safe to say, however, that the higher-grade fertilizers are the most economical ones to buy. Those fertilizers should be purchased which furnish the most nitrogen, potash and phosphoric acid in a suitable and available form for the same money.

TABLE A. — *Average Analysis of Officially Collected Fertilizers for 1905 (Per Cent.).*

Nature of Material.	Moisture.	Nitrogen in One Hundred Pounds. Found.	Nitrogen in One Hundred Pounds. Guaranteed.	Phosphoric Acid in One Hundred Pounds. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in One Hundred Pounds. Found.	Potassium Oxide in One Hundred Pounds. Guaranteed.
Complete fertilizer,	10.79	2.74	2.66	4.24	3.63	2.42	10.24	9.13	7.87	7.07	5.11	4.81
Ground bone,	4.99	3.18	2.98	.15	10.47	14.75	25.16	26.80	10.62	6.00	-	-
Tankage,	9.91	5.82	5.54	.45	9.17	6.49	16.11	12.72	9.62	-	-	-
Dry ground fish,	9.13	9.75	8.21	-	5.14	3.15	6.52	7.43	5.14	-	-	-
Dissolved bone-black,	9.06	-	-	7.65	6.94	2.71	17.30	16.00	14.59	15.00	-	-
Dissolved bone,	10.56	2.81	3.00	1.02	9.12	6.02	16.16	18.00	10.14	13.00	-	-
Acid phosphate,	9.78	-	-	8.41	4.17	1.47	14.08	8.50	12.58	9.00	-	-
Wood ashes,	5.27	-	-	-	-	-	-	-	-	-	-	-
Cotton-seed meal,	6.06	6.70	7.64	-	-	-	1.51	1.00	-	-	5.33	4.40
Flax meal,	7.25	5.74	5.92	-	-	-	-	-	-	-	-	-
Nitrate of soda,	2.38	15.75	15.22	-	-	-	-	-	-	-	-	-
Sulfate of ammonia,	1.25	20.49	19.50	-	-	-	-	-	-	-	-	-
High-grade sulfate of potash,	3.06	-	-	-	-	-	-	-	-	-	49.66	49.42
Muriate of potash,	1.96	-	-	-	-	-	-	-	-	-	50.26	50.13
Dried blood,	9.20	10.11	9.50	-	-	-	1.66	-	-	-	-	-
Kainit,	1.52	-	-	-	-	-	-	-	-	-	12.79	12.00
Castor pomace,	8.26	5.27	4.74	-	-	-	-	-	-	-	-	-
Carbonate potash,	1.95	-	-	-	-	-	-	-	-	-	64.00	64.71
Vegetable potash,	2.85	-	-	-	-	-	-	-	-	-	23.96	25.00
Sulfate potash-magnesia,	1.25	-	-	-	-	-	-	-	-	-	20.56	26.00
Ground South Carolina phosphate,	.85	-	-	-	2.94	25.84	28.78	26.56	2.94	-	-	-

TABLE B. — *Compilation of Analyses of Commercial Fertilizers, Special Crop Brands, for the Year 1905 (Per Cent.).*

NAME OF FERTILIZER.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.			TOTAL PHOSPHORIC ACID IN ONE HUNDRED POUNDS.			AVAILABLE PHOSPHORIC ACID IN ONE HUNDRED POUNDS.			POTASSIUM OXIDE IN ONE HUNDRED POUNDS.		
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
Corn fertilizer,	11.11	3.87	1.02	2.03	16.24	8.32	11.17	12.92	4.70	8.58	12.27	1.74	4.06
Fruit and vine fertilizer,	11.69	3.00	2.16	2.48	10.88	7.60	9.39	9.78	4.68	7.32	11.68	6.20	8.08
Grass fertilizer,	7.57	8.86	1.33	4.19	16.24	4.76	8.94	10.74	2.58	6.54	12.27	1.74	5.72
Market-garden fertilizer,	9.97	4.85	1.84	3.19	13.22	5.04	9.93	10.74	2.58	7.59	12.50	2.02	6.51
Onion fertilizer,	11.11	3.87	1.02	2.03	16.24	8.32	11.17	12.92	4.70	8.58	12.27	1.74	4.06
Potato fertilizer,	10.77	4.98	1.02	2.59	15.00	6.02	10.45	9.86	5.08	8.07	10.18	2.20	5.67
Tobacco fertilizer,	10.70	5.77	.53	3.33	13.30	5.86	10.05	11.10	1.60	7.34	14.84	2.20	7.38
Root crop fertilizer,	8.14	3.76	3.01	3.31	12.06	9.98	10.64	9.66	7.72	8.59	10.04	7.04	8.05

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in the State during the Past Year (May 1, 1905, to May 1, 1906), and the Brands licensed by Each.

The American Agricultural Chemical Co., Boston, Mass.: —
- High-grade Fertilizer with Ten Per Cent. Potash.
- Grass and Lawn Top Dressing.
- Tobacco Starter and Grower.
- Fine-ground Bone.
- Dissolved Bone-black.
- Muriate of Potash.
- Double Manure Salt.
- High-grade Sulfate of Potash.
- Nitrate of Soda.
- Dry Ground Fish.
- Plain Superphosphate.
- Sulfate of Ammonia.
- Kainit.
- Dried Blood.
- Fine-ground Tankage.
- Ground South Carolina Phosphate.

The American Agricultural Chemical Co. (Bradley Fertilizer Co., branch), Boston, Mass.: —
- Bradley's Complete Manure for Potatoes and Vegetables.
- Bradley's Complete Manure for Corn and Grain.
- Bradley's Complete Manure with Ten Per Cent. Potash.
- Bradley's Complete Manure for Top-dressing Grass and Grain.
- Bradley's X L Superphosphate.
- Bradley's Potato Manure.
- Bradley's Potato Fertilizer.
- Bradley's Corn Phosphate.
- Bradley's Eclipse Phosphate.
- Bradley's Niagara Phosphate.
- Bradley's English Lawn Fertilizer.
- Bradley's Columbia Fish and Potash.
- Bradley's Abattoir Bone Dust.
- Church's Fish and Potash.

The American Agricultural Chemical Co. (H. J. Baker & Bro., branch), New York, N. Y.: —
- Baker's A A Ammoniated Superphosphate.
- Baker's Complete Potato Manure.

The American Agricultural Chemical Co. (Clark's Cove Fertilizer Co., branch), Boston, Mass.: —
- Clark's Cove Bay State Fertilizer.
- Clark's Cove Bay State Fertilizer, G. G.
- Clark's Cove Great Planet Manure.
- Clark's Cove Potato Manure.
- Clark's Cove Potato Fertilizer.
- Clark's Cove King Philip Guano.

The American Agricultural Chemical Co. (Crocker Fertilizer and Chemical Co., branch), Buffalo, N. Y.: —
- Crocker's Potato, Hop and Tobacco Phosphate.
- Crocker's Corn Phosphate.

The American Agricultural Chemical Co. (Cumberland Bone Phosphate Co., branch), Boston, Mass.: —
- Cumberland Superphosphate.
- Cumberland Potato Fertilizer.

The American Agricultural Chemical Co. (L. B. Darling Fertilizer Co., branch), Pawtucket, R. I.: —
- Darling's Blood, Bone and Potash.
- Darling's Complete Ten Per Cent. Manure.
- Darling's Potato Manure.
- Darling's Farm Favorite.
- Darling's Potato and Root Crop Manure.
- Darling's General Favorite.

The American Agricultural Chemical Co. (Great Eastern Fertilizer Co., branch), Rutland, Vt.: —
- Great Eastern Garden Special.
- Great Eastern Vegetable, Vine and Tobacco.
- Great Eastern Northern Corn Special.
- Great Eastern General Fertilizer.
- Great Eastern Grass and Oats Fertilizer.

The American Agricultural Chemical Co. (Pacific Guano Co., branch), Boston, Mass.: —
- Pacific High-grade General.
- Pacific Potato Special.
- Soluble Pacific Guano.
- Pacific Nobsque Guano.

The American Agricultural Chemical Co. (Packers' Union Fertilizer Co., branch), Rutland, Vt.: —
- Packers' Union Universal Fertilizer.
- Packers' Union Potato Manure.
- Packers' Union Animal Corn Fertilizer.
- Packers' Union Gardener's Complete Manure.
- Packers' Union Wheat, Oats and Clover Fertilizer.

The American Agricultural Chemical Co. (Quinnipiac Co., branch), Boston, Mass.: —
- Quinnipiac Market-garden Manure.
- Quinnipiac Phosphate.
- Quinnipiac Potato Manure.
- Quinnipiac Potato Phosphate.
- Quinnipiac Corn Manure.
- Quinnipiac Climax Phosphate.
- Quinnipiac Onion Manure.

The American Agricultural Chemical Co. (Read Fertilizer Co., branch), New York, N. Y.: —
- Read's Practical Potato Special.
- Read's Farmers' Friend.
- Read's Standard.
- Read's High-grade Farmers' Friend.
- Read's Vegetable and Vine.

The American Agricultural Chemical Co. (Standard Fertilizer Co., branch), Boston, Mass.: —
- Standard Complete Manure.
- Standard Fertilizer.
- Standard Special for Potatoes.
- Standard Guano.

The American Agricultural Chemical Co. (Henry F. Tucker Co., branch), Boston, Mass.: —
- Tucker's Original Bay State Bone Superphosphate.
- Tucker's Special Potato Fertilizer.

The American Agricultural Chemical Co. (Williams & Clark Fertilizer Co., branch), Boston, Mass.: —
- Williams & Clark's High-grade Special.
- Williams & Clark's Americus Phosphate.
- Williams & Clark's Potato Phosphate.
- Williams & Clark's Potato Manure.
- Williams & Clark's Corn Phosphate.
- Williams & Clark's Royal Bone Phosphate.
- Williams & Clark's Prolific Crop Producer.

The American Agricultural Chemical Co. (M. E. Wheeler & Co., branch), Rutland, Vt.: —
- Wheeler's Bermuda Onion Grower.
- Wheeler's Potato Manure.
- Wheeler's Havana Tobacco Grower.
- Wheeler's Corn Fertilizer.
- Wheeler's Grass and Oats Fertilizer.

W. H. Abbott, Holyoke, Mass.: —
- Abbott's Animal Fertilizer.
- Abbott's Eagle Brand.
- Abbott's Tobacco Fertilizer.

The American Cotton Oil Co., New York, N. Y.: —
- Cotton-seed Meal.
- Cotton-seed Hull Ashes.

The American Linseed Co., New York, N. Y.: —
- Cleveland Flax Meal.

Armour Fertilizer Works, Baltimore, Md.: —
- Armour's Grain Grower.
- Armour's Blood, Bone and Potash.
- Armour's High-grade Potato.
- Armour's All Soluble.
- Armour's Ammoniated Bone with Potash.
- Armour's Bone Meal.
- Armour's Complete Potato.
- Armour's Corn King.
- Armour's Market-garden Fertilizer.

H. J. Baker & Bro., New York, N. Y.: —
- Castor Pomace.

Beach Soap Co., Lawrence, Mass.: —
- Beach's Advance Fertilizer.
- Beach's Reliance Fertilizer.

Berkshire Fertilizer Co., Bridgeport, Conn.: —
- Complete Fertilizer.
- Potato and Vegetable Phosphate.
- Ammoniated Bone Phosphate.

Joseph Breck & Sons, Boston, Mass.: —
- Breck's Lawn and Garden Dressing.
- Breck's Market-garden Manure.

Bowker Fertilizer Co., Boston, Mass.: —
- Stockbridge Special Manures.
- Bowker's Hill and Drill Phosphate.
- Bowker's Farm and Garden Phosphate.
- Bowker's Lawn and Garden Dressing.
- Bowker's Potato and Vegetable Fertilizer.
- Bowker's Fish and Potash (Square Brand).
- Bowker's Potato and Vegetable Phosphate.
- Bowker's Sure Crop Phosphate.
- Gloucester Fish and Potash.
- Bowker's High-grade Fertilizer.
- Bowker's Bone and Wood Ash Fertilizer.
- Bowker's Fish and Potash ("D" Brand).
- Bowker's Corn Phosphate.
- Bowker's Blood, Bone and Potash.
- Bowker's Early Potato Manure.
- Bowker's Bristol Fish and Potash.
- Bowker's Fine-ground Dry Fish.

Bowker Fertilizer Co., Boston, Mass. — *Con.*
- Bowker's Tobacco Ash Elements.
- Bowker's Wood Ashes.
- Bowker's Ground Bone.
- Bowker's Superphosphate.
- Sulfate of Ammonia.
- Nitrate of Soda.
- Dissolved Bone-black.
- Muriate of Potash.
- Sulfate of Potash.
- Dried Blood.
- Bowker's Soluble Animal Fertilizer.
- Bowker's Tobacco Starter.
- Bowker's Tobacco Ash Fertilizer.
- Bowker's Market-garden Fertilizer.
- Bowker's Potash Bone.
- Bowker's Ten Per Cent. Manure.
- Kainit.
- Bowker's Complete Mixture.
- Bowker's Ammoniated Food for Flowers.
- Double Manure Salt.
- Bowker's Tankage.
- Bowker's Clover Brand Bone and Wood Ash.
- Bowker's Flour of Bone.
- Bowker's Market Bone.
- Bowker's Ground Phosphate Rock.
- Bowker's Ammoniated Dissolved Bone.
- Bowker's Square Brand Bone and Potash.
- Bowker's Potash or Staple Phosphate.
- Bowker's Special Fertilizer for Seeding Down.

F. W. Brode & Co., Memphis, Tenn.: —
- Owl Brand Pure Cotton-seed Meal.

T. H. Bunch, Little Rock, Ark.: —
- Cotton-seed Meal.

Charles M. Cox & Co., Boston, Mass.: —
- Cotton-seed Meal.

Chicopee Rendering Co., Springfield, Mass.: —
- Lawn and Garden Dressing
- Vegetable and Potato Fertilizer.

E. Frank Coe Co., New York, N. Y.: —
- E. Frank Coe's High-grade Ammoniated Bone Superphosphate.
- E. Frank Coe's Gold Brand Excelsior Guano.
- E. Frank Coe's Excelsior Potato Fertilizer.
- E. Frank Coe's Tobacco and Onion Fertilizer.
- E. Frank Coe's Columbian Corn Fertilizer.

E. Frank Coe Co., New York, N. Y.— *Con.*
- E. Frank Coe's Columbian Potato Fertilizer.
- E. Frank Coe's New Englander Potato Fertilizer.
- E. Frank Coe's New Englander Corn Fertilizer.
- E. Frank Coe's X X X Pure Ground Bone.
- E. Frank Coe's F. P. Fish and Potash.
- E. Frank Coe's Red Brand Excelsior Guano.
- E. Frank Coe's Celebrated Special Potato.
- E. Frank Coe's Grass and Grain Special.
- E. Frank Coe's X X X Ammoniated Bone Phosphate.
- E. Frank Coe's Muriate of Potash.
- E. Frank Coe's Nitrate of Soda.

John C. Dow & Co., Boston, Mass.: —
- Dow's Pure Ground Bone.

The Eureka Liquid Fertilizer Co., Boston, Mass.: —
- Eureka Liquid Fertilizer.

William E. Fyfe & Co., Clinton, Mass.: —
- Hard Wood Canada Ashes.

R. & J. Farquhar & Co., Boston, Mass.: —
- Clay's London Fertilizer.

C. W. Hastings, Ashmont, Mass.: —
- Ferti Flora.

Thomas Hersom & Co., New Bedford, Mass.: —
- Bone Meal.
- Meat and Bone.

Hunter Brothers Milling Co., St. Louis, Mo.: —
- Prime Cotton-seed Meal.

John Joynt, Lucknow, Ont., Can.: —
- Joynt Brand Hard-wood Ashes.

A. Klipstein & Co., New York, N. Y.: —
- Carbonate of Potash.

Lister's Agricultural Chemical Works, Newark, N. J.: —
- Lister's Success Fertilizer.
- Lister's Special Corn Fertilizer.
- Lister's Special Potato Fertilizer.
- Lister's Potato Manure.
- Lister's High-grade Special for Spring Crops.
- Lister's Oneida Special.
- Lister's Animal Bone and Potash.

Swift's Lowell Fertilizer Co., Boston, Mass.: —
- Swift's Lowell Bone Fertilizer.
- Swift's Lowell Potato Phosphate.
- Swift's Lowell Dissolved Bone and Potash.
- Swift's Lowell Animal Brand.
- Swift's Lowell Market-garden Manure.
- Swift's Lowell Potato Manure.
- Swift's Lowell Empress Brand.
- Swift's Lowell Superior Fertilizer.
- Swift's Lowell Special Grass Mixture.
- Swift's Lowell Lawn Dressing.
- Swift's Lowell Perfect Tobacco Grower.
- Swift's Lowell Ground Bone.
- Swift's Lowell Special Vegetable Manure.
- Acid Phosphate.
- Nitrate of Soda.
- Muriate of Potash.
- Tankage.

George E. Marsh & Co., Lynn, Mass.: —
- Pure Bone Meal.

D. M. Moulton, Monson, Mass.: —
- Ground Bone.

Mapes Formula and Peruvian Guano Co., New York, N. Y.: —
- Mapes' Potato Manure.
- Mapes' Tobacco Starter Improved.
- Mapes' Tobacco Manure (Wrapper Brand).
- Mapes' Economical Potato Manure.
- Mapes' Average Soil Complete Manure.
- Mapes' Vegetable Manure or Complete Manure for Light Soils.
- Mapes' Corn Manure.
- Mapes' Complete Manure ("A" Brand).
- Mapes' Cereal Brand.
- Mapes' Complete Manure Ten Per Cent. Potash.
- Mapes' Top-dresser Improved, Half Strength.
- Mapes' Tobacco Ash Constituents.
- Mapes' Grass and Grain Spring Top-dressing.
- Mapes' Fruit and Vine Manure.
- Mapes' Cauliflower and Cabbage Manure.

National Fertilizer Co., Bridgeport, Conn.: —
- Chittenden's Complete Fertilizer.
- Chittenden's High-grade Special Tobacco.
- Chittenden's Market Garden.
- Chittenden's Potato Phosphate.

National Fertilizer Co., Bridgeport, Conn. — *Con.*
- Chittenden's Ammoniated Bone.
- Chittenden's Fish and Potash.
- Chittenden's X X X Fish and Potash.
- Chittenden's Formula "A."

New England Fertilizer Co., Boston, Mass.: —
- New England Corn Phosphate.
- New England Potato Fertilizer.
- New England Superphosphate.
- New England High-grade Potato Fertilizer.

Olds & Whipple, Hartford, Conn.: —
- Complete Tobacco Fertilizer.
- Vegetable Potash.

R. T. Prentiss, Holyoke, Mass.: —
- Prentiss Complete Fertilizers.

Parmenter & Polsey Fertilizer Co., Peabody, Mass.: —
- Plymouth Rock Brand.
- Special Fertilizer for Strawberries.
- Special Potato Fertilizer.
- Nitrate of Soda.
- A. A. Brand Fertilizer.
- P. & P. Potato Fertilizer.
- Pure Ground Bone.
- Lawn Dressing.
- P. & P. Grain Grower.
- Star Brand Superphosphate.

Rogers & Hubbard Co., Middletown, Conn.: —
- Hubbard's Oats and Top-dressing.
- Hubbard's Grass and Grain.
- Hubbard's Soluble Corn.
- Hubbard's Soluble Potato.
- Hubbard's Soluble Tobacco.
- Hubbard's All Soils and All Crops.
- Hubbard's Corn Phosphate.
- Hubbard's Potato Phosphate.
- Hubbard's Market-garden Phosphate.
- Hubbard's Raw Knuckle Bone Flour.
- Hubbard's Strictly Pure Fine Bone.

Rogers Manufacturing Co., Rockfall, Conn.: —
- All Round Fertilizer.
- Complete Potato and Vegetable Fertilizer.
- High-grade Complete Corn and Onion.
- Fish and Potash.
- High-grade Tobacco and Potato.
- High-grade Oats and Top-dressing.
- High-grade Grass and Grain.
- High-grade Soluble Tobacco.
- Pure Knuckle Bone.

Ross Bros., Worcester, Mass.: —
- Ross Brothers' Lawn Dressing.

N. Roy & Son, South Attleborough, Mass.: —
- Complete Animal Fertilizer.

Russia Cement Co., Gloucester, Mass.: —
- Essex Dry Ground Fish.
- Essex Complete Manure for Potatoes, Roots and Vegetables.
- Essex Complete Manure for Corn, Grain and Grass.
- Essex Market-garden and Potato Manure
- Essex Corn Fertilizer.
- Essex A I Superphosphate.
- Essex X X X Fish and Potash.
- Essex Odorless Lawn Dressing.
- Essex Tobacco Starter.
- Essex Special Tobacco Manure.
- Essex Rhode Island Special.
- Essex Grass and Top-dressing.
- Essex Nitrate of Soda.

Sanderson's Fertilizer and Chemical Co., New Haven, Conn.: —
- Sanderson's Formula "A".
- Sanderson's Formula "B".
- Sanderson's Potato Manure.
- Sanderson's Corn Superphosphate.
- Sanderson's Fine-ground Fish.
- Sanderson's Sulfate of Potash.
- Walker's Complete Phosphate.
- Walker's Complete Fertilizer.
- Walker's High-grade Fertilizer.
- Niantic Bone, Fish and Potash.
- Old Reliable Superphosphate.

The Smith Agricultural Chemical Co., Columbus, O. (Abbott & Martin Rendering Co., branch): —
- Harvest King.
- Tobacco and Potato Special.

The Smith Agricultural Chemical Co., Columbus, O. (Hardy Packing Co., branch): —
- Tankage Bone and Potash.
- Tobacco and Potato Special.

M. L. Shoemaker & Co., Limited, Philadelphia, Pa.: —
- Swift Sure Superphosphate.
- Swift Sure Bone Meal.

Thomas L. Stetson, Randolph, Mass.: —
- Bone Meal.

A. L. Warren, Northborough, Mass.: —
- Warren's Ground Bone.

The Whitman & Pratt Rendering Co., Lowell, Mass.: —
- Whitman & Pratt's All Crops.
- Whitman & Pratt's Corn Success.
- Whitman & Pratt's Vegetable Grower.
- Whitman & Pratt's Potash Special.
- Whitman & Pratt's Pure Ground Bone.
- Whitman & Pratt's Potato Plowman.

Wilcox Fertilizer Works, Mystic, Conn.: —
- Wilcox Potato, Onion and Tobacco Manure.
- Wilcox Potato Fertilizer.
- Wilcox Complete Bone Superphosphate.
- Wilcox Fish and Potash.
- Wilcox High-grade Tobacco Special.
- Wilcox Dry Ground Fish.

Sanford Winter, Brockton, Mass.: —
- Pure Fine-ground Bone.

J. M. Woodward & Bro., Greenfield, Mass.: —
- Tankage.

Part II. — Report on General Work in the Chemical Laboratory.

C. A. GOESSMANN.

1. Analyses of materials forwarded for examination.
2. Notes on wood ashes and lime ashes.

1. Analyses of Materials forwarded for Examination.

We have received 257 samples of miscellaneous substances, during the season, from farmers within our State. As far as circumstances and time permit we have taken up these materials for analysis, and as a general thing have reported results in the order of their arrival at this office. As in the past, we have been obliged to neglect this class of work until a lull occurred in the official inspection of commercial fertilizers. From December to April we have most time to devote to the investigation of general material, and for this reason would prefer to have the samples forwarded whenever possible, so they may be taken up during these months. This would insure more prompt reports of the results of analyses.

We have taken the usual active part in the technical chemical work of the Association of Official Agricultural Chemists for the establishment of new methods of chemical analysis, more particularly in regard to fertilizer work and the analysis of insecticides. We have also been in co-operation with the American Chemical Society and the United States Geological Survey in regard to technical details in the chemical analysis of argillaceous limestone. The results of these analyses were sent to the respective parties in Washington.

Following is a list of materials forwarded by farmers during the year: —

Soils,	54	Factory waste,	2
Wood ashes,	47	Ashes from leather scraps,	2
Complete fertilizers,	32	Insecticides,	2
Cotton-seed meal,	24	Oyster shells,	1
Lime ashes,	8	Sulfate of ammonia,	1
Miscellaneous materials,	7	Blood,	1
Nitrate of soda,	6	Wool waste ashes,	1
Manure,	6	Chicken grit,	1
Muck,	5	Tobacco dust,	1
Tankage,	4	Argillaceous limestone,	1
Superphosphate,	4	Burned bone,	1
Cotton-hull ashes,	4	Low-grade sulfate of potash,	1
High-grade sulfate of potash,	3	River mud,	1
Ground bone,	3	Cob ashes,	1
Bone and meat,	3	Castor pomace,	1
Sheep manure,	3	Linseed meal,	1
Peruvian guano,	3	Mud from seaweed,	1
Peat,	3	Cotton-seed compost,	1
Dry ground fish,	2	Damaged cocoa,	1
Dissolved bone-black,	2	Prepared bone,	1
Wood charcoal,	2	Vegetable potash,	1
Muriate of potash,	2	Rotten cotton waste,	1
Carbonate of potash,	2		

2. Notes on Wood Ashes and Lime Ashes.

(a) *Wood Ashes.*

Eighteen and one-half per cent. of the materials forwarded by farmers during the year have been wood ashes. The following table shows their chemical composition as compared with the previous year: —

Analysis of Wood Ashes.

	Number of Samples.	
	1904.	1905.
Moisture from 1 to 10 per cent.,	18	15
Moisture from 10 to 20 per cent.,	16	20
Moisture from 20 to 30 per cent.,	8	7
Moisture above 30 per cent.,	3	1
Potassium oxide above 8 per cent.,	2	4
Potassium oxide from 6 to 7 per cent.,	8	4
Potassium oxide from 5 to 6 per cent.,	6	12
Potassium oxide from 4 to 5 per cent.,	12	13
Potassium oxide from 3 to 4 per cent.,	10	7
Potassium oxide below 3 per cent.,	7	3
Phosphoric acid above 2 per cent.,	3	7
Phosphoric acid from 1 to 2 per cent.,	30	32
Phosphoric acid below 1 per cent.,	12	4
Average per cent. of calcium oxide (lime),	30.16	32.30
Insoluble matter below 10 per cent.,	6	9
Insoluble matter from 10 to 15 per cent.,	18	14
Insoluble matter above 15 per cent,	20	20

Table showing the Maximum, Minimum and Average Per Cents. of the Different Ingredients found in Wood Ashes, 1904 and 1905.

	Maximum.		Minimum.		Average.	
	1904.	1905.	1904.	1905.	1904.	1905.
Moisture at 100° C.,	37.85	32.05	none.	.02	14.42	13.45
Potassium oxide,	11.04	8.68	.80	2.32	4.51	5.09
Phosphoric acid,	6.07	4.74	.28	.38	1.37	1.67
Calcium oxide,	42.86	49.24	19.73	21.17	30.16	32.30
Insoluble matter,	47.21	33.32	4.56	4.15	18.35	15.49

From the above comparison it will be seen that the ashes analyzed during the year are of much better quality than for the year 1904. We wish to urge parties who buy wood ashes to patronize those importers and dealers who have secured a license for the sale of ashes in Massachusetts, for it is only in this way that they can secure protection by our State laws. Wood ashes should always be bought on a statement of guarantee of potash, phosphoric acid and lime.

(b) *Lime Ashes.*

Table showing the Maximum, Minimum and Average Per Cents. of the Different Ingredients found in Lime Ashes, 1904 and 1905.

	Maximum.		Minimum.		Average.	
	1904.	1905.	1904.	1905.	1904.	1905.
Moisture,	36.62	19.35	none.	.05	10.88	11.18
Potassium oxide,	2.46	4.80	.06	1.02	1.54	2.47
Phosphoric acid,	1.48	1.58	trace.	.18	.74	.97
Calcium oxide,	55.24	63.44	21.92	37.56	42.93	49.34
Insoluble matter,	25.47	28.93	2.76	3.21	8.11	8.99

It will be seen from the above comparison that the average composition of lime ashes for the past year is superior to that of 1904. The only safe way to buy lime ashes is to insist upon a guarantee of potash, phosphoric acid and lime which they are said to contain.

REPORT OF THE CHEMIST.

DIVISION OF FOODS AND FEEDING.[1]

J. B. LINDSEY.

Chemical Assistants: E. B. HOLLAND, P. H. SMITH, E. S. FULTON,[2] A. C. WHITTIER.

Inspector of Feeds and Babcock Machines: A. PARSONS,[3] F. G. HELYAR.

Dairy Tester: S. R. PARKER.

In Charge of Feeding Experiments: J. G. COOK,[4] R. F. GASKILL.

Stenographer: MABEL C. SMITH.

PART I. — THE WORK OF THE YEAR.

1. Correspondence.
2. Summary of laboratory work.
3. Water analysis.
4. Dairy products and cattle feeds.
5. Special chemical work.
6. Feed control.
7. Act for protection of dairymen.
8. The testing of pure-bred cows.
9. Work completed.
10. Work in progress.
11. Changes in staff.

PART II. — EXPERIMENTS IN ANIMAL NUTRITION.

1. Bibby's dairy cake.
2. Eureka silage corn.
3. Concerning wheat bran.

[1] See also tables in Appendix.

[2] Resigned Sept. 15, 1905.

[3] Resigned July 1, 1905.

[4] Resigned Aug. 1, 1905.

Part I. — The Work of the Year.

J. B. LINDSEY.

1. Correspondence.

The answering of inquiries relative to feeding and dairy problems has continued to be a feature of the correspondence of this department. Grain dealers appear desirous of being well posted on the various feed stuffs in the market, and are constantly writing for information. The total number of letters of all kinds sent out during the year was approximately 3,600.

2. Summary of Laboratory Work.

The usual variety of chemical work has been carried out during the year.

There have been sent in for examination 102 samples of water, 792 of milk, 1,717 of cream, 5 of butter, 191 of feed stuffs and 6 miscellaneous. In connection with experiments by this and other divisions of the station, there have been analyzed, in whole or in part, 236 samples of milk and cream and 142 of fodders and feed stuffs. This makes a total of 4,042 substances analyzed during the year, as against 4,261 last year and 3,897 in the previous year. Work on the determination of sulphur in organic bodies, and nitrogen compounds in cheese, not included in the above, has been done for the Association of Official Agricultural Chemists. In addition, 13 candidates have been examined and given certificates to operate Babcock machines, and 1,665 pieces of glassware have been tested for accuracy, of which 197 pieces, or 11.83 per cent., were condemned.

3. Water Analysis.

The experiment station has made a feature of sanitary water analysis since its establishment in 1882. Within a few years a charge of $3 a sample has been placed upon this work, in order to hold in check many who have seemingly abused the privilege of free analysis. Instructions for securing an analysis are issued in circular form, as follows: —

Those wishing to secure a sanitary analysis of water must first make application, whereupon a glass bottle securely encased, accompanied by full instructions for collecting and shipping the sample, will be forwarded by express. The return express must in all cases be prepaid. Because of the smallness of the sum involved, no account will be opened. Remittance by check, P. O. money order, or money at the owner's risk, must be strictly in advance.

Address Dr. J. B. Lindsey,
Hatch Experiment Station, Amherst, Mass.

The results of the analysis are forwarded on especially prepared blanks, with such additional remarks concerning the condition of the water, and its possible improvement, as is warranted in each case. This station does not make mineral analysis of water, excepting at rare intervals by special arrangement.

4. Dairy Products and Cattle Feeds.

This department makes free analyses of milk, cream and cattle feeds for farmers and others, in so far as its resources permit. About the usual number have been received during the year. Many farmers and dairymen desire to know the percentage of fat and total solids in the milk produced by their herd and by individual animals, and send samples to the station for analysis. They are thus enabled to determine the quality of the product placed upon the market, and also the value of the cow for profitable milk production. The quality of the milk shipped to Boston is carefully scrutinized by the several contractors, and producers frequently send samples to the station, to ascertain whether their product is conforming to the legal requirements. Parties who have been warned by the contractors, or have had their milk refused, likewise forward samples, with requests for information as to methods of betterment. The station tries to be as helpful as possible in all such cases. One creamery sends its samples regularly, and others send occasional lots, when not in condition to satisfactorily perform the work, or when desiring to check their own results. A charge is made in such cases sufficient to cover the cost of the work.

Farmers and grain dealers are constantly sending samples of feeds for examination, to determine their value and whether they are as represented. This work takes considerable time, but it is worthy of encouragement. It must not be understood, however, that the station furnishes a free chemical laboratory for jobbers and manufacturers who wish to ascertain the composition of their feeds for commercial purposes. The station does not solicit work of this character, but is willing to undertake a limited amount for a reasonable compensation.

5. Special Chemical Work.

During the year the department has undertaken co-operative work on chemical methods in connection with the Association of Official Agricultural Chemists, and has studied particularly methods for the determination of sulphur in organic substances, and of nitrogenous compounds in cheese. The department has also co-operated with the department of botany in ascertaining the amount of starch and sugars in cucumber leaves, grown under definite conditions.

6. Feed Control (Acts of 1903, Chapter 202).

The several provisions of this act have been executed as heretofore. Bulletin No. 101, containing the analyses of 306 samples of feeds collected the previous autumn, was distributed early in January of 1905. This bulletin also contained many remarks and suggestions on the nutritive and commercial values of concentrates. Bulletin No. 106, sent out in October, 1905, gave the chemical and microscopic analyses of 65 samples of condimental stock and poultry foods, and the results of an experiment with Pratt's food. During the months of January, February, March and April, the inspector twice visited the most important cities and towns in the State, and collected 481 samples of feeds. The entire collection was tested during the late spring and early summer. For financial reasons, it was not possible to publish the results in bulletin form. Those that were considered at all suspicious were examined by both the chemist and the microscopist, and the attention of retail dealers, jobbers and manufacturers called to any irregularities. Brief notes regarding this collection were published in Bulletin No. 106. The inspector canvassed the entire State in September and October, and the 365 samples collected are now being examined, and the results will be ready for publication in December.

The large majority of manufacturers, jobbers and retailers willingly conform to the requirements of the law. Considerable difficulty is frequently experienced in obtaining a statement in full, many omitting the weight of the package, and a few stating the protein and fat guarantees together. Some manufacturers and jobbers have been lax in attaching any guarantee whatever, and retailers have frequently offered unguaranteed goods for sale. The station has endeavored to be very patient with offenders, giving them full opportunity to conform to the statute requirements. The writer recognizes the diversity of conditions governing the purchase and sale of the great variety of concentrated feeds, and has been willing to condone many technical violations of the law, when it appeared that no intentional offence was intended. Some parties seem inclined to take advantage of this seeming leniency, and such it may be necessary to call to a sharp account.

The value of an intelligent and tactful inspector cannot be too strongly emphasized. He is in position to impart much valuable information to the dealer, and to smooth out many difficulties that may arise. The station finds it difficult to retain the services of a satisfactory person for any length of time, because of the small salary paid.

The great bulk of feed now offered is free from intentional adulteration, and is as represented. Buyers, as a rule, have only themselves to blame if they are defrauded. Much cotton-seed meal is being guaranteed several per cent. lower in protein than formerly, manufacturers claiming that it does not pay them to completely remove the hulls. It is also stated that this lower-grade meal is shipped from other territory than that formerly supplying the Massachusetts markets.

Gluten feed and wheat by-products tested low in protein during 1905, owing to the inferior character of the 1904 corn and wheat.

Porto Rico molasses and a considerable variety of molasses feeds are being freely offered. The station is making a special study of these products, and hopes to publish the results in bulletin form within the next few months.

Rice by-products in considerable quantity are being sold in the southwest, but as yet they have not been offered in local markets. Detailed information concerning the composition and value of concentrates may be obtained by consulting the special bulletins on the subject.

7. An Act for the Protection of Dairymen (Acts of 1901, Chapter 202).

This act makes it obligatory for all creameries and milk depots within the State, employing the Babcock test or any other test for determining the value of milk or cream, to have all graduated glassware used in making such determinations tested for accuracy by this station. It further requires that all parties intending to operate such machines must first be examined for competency by the proper official of the station. Once each year the station is obliged to send a competent party to each creamery and milk depot within the State where such machines are in use, to duly inspect said machines and pronounce upon their fitness for the work. This department has endeavored to carry out the several provisions of this law with the same care as formerly. The following is a brief report of the work for 1905: —

Inspection of Glassware. — All glassware found to be correctly graduated has been marked "Mass Ex St." There were 1,665 pieces examined, of which 197, or 11.83 per cent., were condemned. The inaccurate bottles were largely of the bulb type (Bartlett). Until last year these bottles have been passed on accuracy of total graduation, as the usual charge of 5 cents a piece would not permit of additional testing. Because of the difficulty in securing a correct graduation, it has been necessary to test the three distinct portions of the scale at a corresponding increase in cost. The use of this type of bottle is not to be encouraged.

Examination of Candidates. — A few less candidates than usual were examined, and 13 certificates of competency issued. Many candidates showed poor manipulation, and lacked a thorough understanding of the method. In case of failure, applicants are obliged to wait a month before a second examination will be given.

Inspection of Babcock Machines. — The inspection of machines the present year has been in charge of Mr. Frank G. Helyar, who makes the following report: —

The annual inspection of Babcock machines was made in November and December. Fifty-two places were either visited or heard from, of which number only 36 were amenable to the inspection. Those creameries or milk depots that did not come under the inspection were exempt for two reasons: some of them do not possess a machine, but have their samples regularly tested by city inspectors; while others have machines, but from all that can be learned they neither buy nor sell milk or cream on the results of their own tests. In suspicious cases they carry samples to the city inspector. There are three creameries paying by the space and one by the churn test.

Of the total number, 34 were creameries and 18 were milk depots. Of the 34 creameries, 19 were situated west of the Connecticut River, and, as a rule, in the back-hill towns, away from good transportation facilities. The rest of the creameries were scattered throughout the eastern part of the State. The milk depots, on the other hand, are situated nearer the large cities. Twenty of the milk depots and creameries were co-operative, while the rest were either proprietary or stock companies. The number of co-operative creameries is steadily decreasing.

As a whole, the machines were found to be in very good condition, none being condemned, and only 3 needing repairs. The cast-iron machine is being used in every place visited but 4. The Facile is used in 19 places, the Agos in 9 and the Wizard in 3.

Most of the owners of the Babcock machines have recognized the value of a substantial foundation as a factor in keeping their machines in good repair. Still, there are a few machines that are being used on rather insecure and shaky supports. As a result, these machines are always a little out of level, and run with more or less unnecessary vibration. Some machines, even with repairs suggested in previous inspections, still overheat the samples. The operators of these machines counteract this by allowing the machine to run a few moments at the end of the test with the cover lifted. No machine was found that insufficiently heated the samples. The steam gauges, with only one or two exceptions, were found to be in good order. In those cases where they were not in good order, speed indicators are used to check up the speed of the machines.

Only in one place was untested glassware found. In some cases it was not as clean as it ought to be, but, on the whole, may be said to be in very good condition.

In addition to the regular work of the inspection, 4 city milk inspectors were visited. Only 1 desired an examination. His machine, an electrical Wizard, was given a certificate.

The above law is not as comprehensive as one could wish. It makes no financial provision for the purpose of carrying out the provisions of section 3 (inspection of machines), but requires the director of the station, or his agent, to make the inspection, and to assess the cost upon the several creameries inspected. The station is obliged to advance the expense out of its treasury, and collect 35 or 40 small bills resulting. Most creameries pay with a reasonable degree of promptness, but a few parties are obstinate and slow.

After the station has issued a certificate of competency to the operator of a Babcock machine, it has no further control over said party, even though he may prove careless, and even dishonest in his future operations. The law could be improved, and thus give a fuller measure of protection to dairymen, by a small annual State appropriation, together with the necessary authority to make a semi-annual inspection of all Babcock or similar machines, and of all glassware used in connection therewith, and by empowering the director of the experiment station, or some other competent party, to rescind the license of all operators who do not appear to be satisfactorily performing their duties.

8. The Testing of Pure-bred Cows.

Breeders of pure-bred Jersey, Guernsey and Holstein cattle are making tests of the weekly and yearly yields of milk and butter fat produced by their cows, under the rules and regulations of the several national cattle clubs. The rules require that these tests be made under the strict supervision of an officer of the Agricultural College or Experiment Station. This department has undertaken the work for Massachusetts breeders. Considerable more testing has been required during 1905 than heretofore, necessitating the temporary employment of 5 different inspectors at one time. It is frequently quite difficult and time-consuming for the regular employees to be required to meet the sudden demands of breeders for men to do work of this character, although thus far all calls for men and apparatus have been met promptly. Breeders ought to give the station at least ten days' notice. The cost of this work is paid by the parties for whom it is done, and includes tester's time at $2 to $2.50 a day, board, travelling expenses and breakage. There are at present 44 Jerseys and 29 Guernseys under yearly tests, belonging to F. L. Ames, North Easton, N. I. Bowditch, Framingham, W. L. Cutting, Pittsfield, C. H. Jones, Wellesley Farms, A. H. Sagendorph, Spencer, Storrs Agricultural College, Storrs, Conn., C. I. Hood, Lowell, A. F. Pierce, Winchester, N. H., and R. A. Sibley, Spencer. Eight seven-day milk and butter fat tests have been made for the Jersey Cattle Club, and 37 for the Holstein-Friesian Association, and the yearly tests of 32 Jerseys and 12 Guernseys have been completed.

9. Work completed.

Eureka Silage Corn. — A two-years experiment, to study the composition, digestibility and economic value of this corn, a coarse southern dent, as compared with a medium dent that will mature its seed in our latitude, has been completed, and the details and conclusions reported in Part II. of the present report.

The Value of Wheat Bran. — The results of a study of the cost of digestible protein and total digestible matter in wheat bran, as well as the use of bran in the farm economy, are presented quite fully in Part II.

Bibby's Dairy Cake. — Digestion tests and an experiment with dairy cows have been completed with this feed. The details of the experiment, and the conclusions, will be found as a portion of Part II.

Market Milk, its Production and Composition. — This department has investigated the conditions governing the production of milk in the territory supplying Amherst and Northampton, as well as the chemical and bacteriological composition of the milk. It is believed that the methods of production and the quality of the product are much the same as in other sections of the State. In general, it may be said that: —

1. The sanitary conditions on the whole were unsatisfactory.

2. The majority of producers were not familiar with, or did not apply, the teachings of modern dairy principles.

3. The chemical composition of most of the milk was above the Massachusetts standard.

4. A great deal of the milk contains an excess of bacteria, and indicated unsanitary methods of handling.

5. The milk was practically all retailed at 6 cents a quart, — a price too low to enable the producer to profitably produce an article under satisfactory sanitary conditions.

It is believed that producers supplying milk for human consumption should be subject to a system of regular, competent inspection, and that no one should receive a license who does not conform to reasonable sanitary conditions. The public needs to be educated relative to the great food value of milk, and ought to be willing to pay a fair price for an approved article. It is hoped to soon publish the detailed results of this investigation in bulletin form.

Digestion Experiments with Sheep. — There have been completed digestion experiments with soy bean fodder, Eureka corn fodder and Eureka corn stover, Pride of the North corn stover, Blomo feed for horses, malt sprouts, Sucrene, Holstein and Macon sugar feeds, hominy feed, buckwheat and oat middlings. The results have been incorporated in the tables of digestion coefficients, in the Appendix. The details of these experiments and a discussion of the results are reserved for a future publication.

Sorghum and Other Forage Crops. — Trials of a variety of green crops for summer soiling are conducted each year. Sorghum has been given particular attention for the last two years. A very complete analysis of this crop has been made at different stages of growth, and, likewise, digestion trials with sheep, the results of which are not as yet completed. The seed [1] was sown broadcast at the rate of 1 bushel per acre, the 25th of May. Cutting was begun as soon as the heads appeared (about August 10), and the yield was at the rate of 19 tons to the acre. The animals ate it well, and it should prove a satisfactory addition to the list of green feeds. A more detailed statement concerning the quality and value of this crop for soiling will be given in a future publication.

The station has found the following crops quite satisfactory for soiling purposes: peas and oats, the first seeding to be made April 25 and each ten days thereafter, ready to cut from June 25 to July 20; barnyard millet, first seeding to be made May 25 and another seeding two weeks later, ready for feeding from July 20 to August 10; sorghum to be seeded May 25, ready to cut August 10 to 30; Stowell's Evergreen sweet corn, or Longfellow field corn, seeded May 15 to 20, will serve admirably for September green fodder, and later if frosts are not severe.

Soy beans may be sown with the corn, but it is believed that, on the whole, more satisfactory results can be obtained by cultivating each crop separately. It is hoped to publish a bulletin on the subject of soiling in the near future. Copies of a former bulletin on this subject (No. 72) are not available.

Useful Legumes. — A study has been made of the composition, digestibility and yields of the more prominent leguminous crops, with a view to determine their practical adaptability to New England conditions, and it is desired

---

[1] Seed purchased of Wm. Henry Maule, Philadelphia, Pa., at $2.25 a bushel.

to publish a concise description of this work in the near future.

Clover is unquestionably the most valuable legume, serving admirably as a soil renovator, cover crop, soiling crop, and as a component of the hay crop. Canada peas are valuable chiefly for soiling purposes, and in some cases as a cover crop. Sand vetch (*Vicia sativa*) makes a good legume to be sown in the autumn with wheat for early summer soiling. It also serves as a soil renovator and as a cover crop. Shammel, in Bulletin No. 149 of the Connecticut Experiment Station, has called attention to the value of this plant when sown after the removal of tobacco. It blossoms about June 1, and can then be plowed under, adding materially to the humus and nitrogen content of the soil. It seeds poorly, and the seed is very expensive, which will naturally much restrict its use. Alfalfa has been tried repeatedly on the station ground under favorable conditions, but it has not as yet proved a satisfactory crop for practical purposes. It is affected with "leaf-spot," winter-kills, and is crowded out by clover and grasses. Occasionally one hears of successes by Massachusetts farmers. It is suggested that our farmers try it in a small way (¼ acre), and see if it will thrive in their locality. Soy beans (Brooks's medium green) and several varieties of cow peas have been carefully studied; the latter are best suited to a more southern climate. The soy beans thrive well in Massachusetts, and may be used with satisfaction as a soiling crop, and mixed with corn for silage purposes. It is believed, however, that it will prove more economical, as a rule, for farmers and dairymen possessing satisfactory markets and railroad facilities to purchase their protein in the form of high-grade concentrates, rather than attempt to grow it in the form of soy bean forage or seed. Soy beans may prove an economical crop for localities situated at some distance from markets and railroads.

Compilation of Analyses. — Attention is called to the tables of composition and digestion of American feed stuffs, recently compiled, and published in the Appendix to this report.

10. Work in Progress.

Molasses and Molasses Feeds. — Work is in progress to determine the digestibility and comparative value and place in the farm economy of Porto Rico molasses and molasses feeds. Feeds of this character are being freely advertised and sold in our local markets. It is hoped to bring this work to a close early in the new year, and to report the results in bulletin form within a short time thereafter.

Nitro-cultures for Legumes. — The United States Department of Agriculture has called attention to the value of the cultures produced by its expert, Dr. Moore, for the different leguminous crops. Hellriegel of Germany was the first to scientifically demonstrate the symbiotic action of bacteria with the legumes, resulting in the fixation of atmospheric nitrogen. This subject has been given a great deal of study by many other scientists, particularly by Nobbe and his co-workers, who have isolated and prepared cultures suited to the different varieties of legumes. Moore claims that he has succeeded in isolating and developing varieties of bacteria that are especially active as nitrogen gatherers. This department has secured the Moore cultures for two years, and used them upon alfalfa, soy beans and cow peas. The directions were carefully followed in all cases, but no particular results were obtained that could be attributed directly to the action of the applied cultures. The yields for the soy bean and cow pea plots receiving the cultures were no greater than those not receiving them, neither did the plots thus treated show any noticeable increased nodular development. A newly seeded piece of alfalfa, inoculated with soil from an old alfalfa field, seemed to receive a decided help from the treatment, judging from the growth and apparent vigor of the plants. The writer would in no way condemn the Moore cultures, knowing the progress that has been achieved by numerous investigators along this line. Farmers may try the Moore cultures in a small way, but should not be disappointed if the results are not as expected. The daily press and popular journals have made altogether too extravagant statements and claims regarding them. Work of this character still requires much study before the highest practical results are secured.

11. Changes in Staff.

Albert Parsons, B.S., for two years employed as inspector of concentrated feeds and of Babcock machines, resigned July 1, to accept a position as assistant superintendent at Hood Farm, Lowell, Mass. His place has been filled by the appointment of Frank G. Helyar, B.S., University of Vermont, 1905. Joseph G. Cook, B.S., assistant in animal nutrition, resigned August 1, to become superintendent of the farm at Norfolk, Mass., belonging to T. D. Cook & Co. Roy F. Gaskill, a recent graduate of the Massachusetts Agricultural College dairy course, succeeds him. E. S. Fulton, B.S., assistant chemist, severed his connection with this department September 15, having received an appointment with Dr. F. G. Benedict of Wesleyan University of Middletown, Conn., who has charge of the nutrition investigations for the United States Department of Agriculture. Mr. A. C. Whittier, B.S., University of Maine, 1905, has taken Mr. Fulton's place. The writer desires to express his highest appreciation of the faithfulness, interest and care exercised by all his co-workers in the prosecution of the various lines of work undertaken by this department during the past year.

Part II. — Experiments in Animal Nutrition.

1. Bibby's Dairy Cake.

J. B. LINDSEY.[1]

Nature and Composition of the Cake.

This material is made by J. Bibby & Sons, Liverpool, Eng., and is imported in the form of cake. It is composed chiefly of ground cotton-seed, together with locust or carob bean,[2] cereals (maize, wheat, etc.) or their by-products, fenugreek and salt; it possesses a pleasant taste and smell. A number of samples have been found that were quite mouldy, having probably been stored in a damp place. The sample used in the feeding experiment herein described had the following composition: —

	Bibby's Dairy Cake.	Standard Wheat Middlings for Comparison.	Gluten Feed for Comparison.
Water,	11.96	10.00	9.69
Ash,	7.89	4.30	1.40
Protein,	17.99	18.00	23.55
Fiber,	7.91	7.00	7.15
Extract matter,	45.05	55.70	55.08
Fat,	9.20	5.00	3.13

The cake has a high ash percentage, due partly to the presence of added salt, a moderate amount of protein and

[1] With E. B. Holland, P. H. Smith and J. G. Cook.

[2] The locust or carob tree is cultivated in Spain, the eastern Mediterranean regions and Egypt. The pods contain considerable quantities of sugar, and are eaten by both men and animals.

fiber, and quite a noticeable per cent. of fat. It is guaranteed to contain 18 to 20 per cent. of protein and 6 to 8 per cent. of fat, and usually meets these requirements. It has not been found to be very generally distributed.

Digestibility of Bibby's Dairy Cake.

The average results of six single trials with sheep are here given, together with the coefficients for standard wheat middlings and gluten feed for comparison. The full details of the digestion experiment have been reported in the seventeenth report of this station.

Coefficients of Digestibility.

	Bibby's Dairy Cake.	Standard Wheat Middlings for Comparison.	Gluten Feed for Comparison.
Dry matter,	70	73	85
Ash,	33	25	-
Protein,	66	77	85
Fiber,	31	30	76
Extract matter,	81	78	89
Fat,	92	88	83

In the several trials with Bibby's dairy cake the sheep experienced considerable difficulty in digesting the crude fiber, due probably to the fact that it was derived largely from cotton-seed hulls. It may be said that the total cake proved moderately digestible, the fiber having a low and the fat a high digestibility. Both in chemical composition and in digestibility Bibby's dairy cake closely resembled standard wheat middlings. Gluten feed contains 5 to 6 per cent. more protein, and is more digestible than the cake.

Cost of Digestible Matter.

	Bibby's Dairy Cake.	Standard Wheat Middlings.	Gluten Feed.
Pounds digestible matter in 2,000 pounds.	1,232	1,314	1,550
Cost of one pound (cents),	2.43	2.11	1.72

The above figures are based on the average wholesale prices of middlings and gluten feed for the year 1904, plus 10 per cent.; namely, $26.70 for middlings and $27.72 for gluten feed. Bibby's dairy cake cost $30 a ton. The calculations show that a ton of wheat middlings furnished rather more digestible matter than a ton of Bibby's dairy cake, and at a somewhat less cost a pound. They further show that, if 1,550 pounds of digestible matter in a ton of gluten feed could be purchased for $27.72, 1,232 pounds, being the quantity contained in a ton of Bibby's dairy cake, ought not to cost over $22. In other words, Bibby's dairy cake at $30 a ton furnishes digestible matter at some 37 per cent. advance over that contained in gluten feed at $27.72 a ton.

Feeding Experiment with Bibby's Dairy Cake, Spring, 1904.

In order to test the efficacy of this cake as a food for milk production, four cows were divided as evenly as possible into two groups, and fed by the reversal method. All of the cows received first-cut hay, rowen and bran as a basal ration. In the first half, two of the cows received a definite quantity of the dairy cake and the other two a like quantity of gluten feed; in the second half, these two grain feeds were reversed.

Duration of Experiment.

Periods.	Dates.	Gluten Feed Ration.	Bibby's Dairy Cake Ration.
I., . .	May 7 through May 27.	Red II. and Brighty.	Linnie and Blanche.
II., . .	June 4 through June 24.	Linnie and Blanche.	Red II. and Brighty.

Care of the Animals. — The cows were kept in roomy stalls, well carded, and turned into the yard some six or more hours each pleasant day.

Method of Feeding. — The animals were fed twice daily, the hay being given about an hour before milking, and the grain mixtures just before milking. The several grains were well mixed before being fed. Bibby's dairy cake was ground to the fineness of ordinary meal. Water was supplied the animals constantly by means of a self-watering device.

Character of Feeds. — The first-cut hay was a mixture of Kentucky blue-grass, timothy and red clover. The rowen was a mixture of second growth of grass and red clover, secured in good condition. The spring bran, gluten feed and Bibby's dairy cake were of good average quality.

Weighing the Animals. — The animals were weighed for three consecutive days at the beginning and end of each half of the trial.

Sampling Feeds. — The hay and rowen were sampled at the beginning, middle and end of each half of the trial, dry matter determinations made at once, and the several samples mixed for analysis. The grains were sampled daily, and preserved in glass-stoppered bottles. The cows received two ounces of salt daily.

Sampling the Milk. — The milk of each cow was sampled twice daily for five consecutive days of each week, and preserved with formaline in tightly corked bottles. The method of sampling consisted in mixing the freshly drawn milk with an especially constructed mixer, and immediately removing a small dipperful. Determinations of fat were made weekly, and solids every other week.

History of the Cows, Spring, 1904.

Name.	Breed.	Age (Years).	Last Calf dropped.	Number of Days with Calf.	Milk Yields, Beginning of Experiment (Pounds).
Red II., .	Jersey-Durham,	8	December, 1903.	59	30
Brighty, .	Grade Jersey, .	8	August, 1903.	124	17
Linnie, .	Grade Jersey, .	7	October, 1903.	65	21
Blanche, .	Grade Jersey, .	9	August, 1903.	121	22

Daily Rations consumed (Pounds).

Ration.	Cows.	Hay.	Rowen.	Bran.	Gluten Feed.	Bibby's Dairy Cake.
Gluten feed, . .	Red II., .	18	6	4	4	–
	Brighty, .	14	6	3	3	–
	Linnie, .	14	6	3	3	–
	Blanche, .	17	6	3	4	–
Bibby's dairy cake, .	Red II., .	18	6	4	–	4
	Brighty, .	14	6	3	–	3
	Linnie, .	14	6	3	–	3
	Blanche, .	17	6	3	–	4
Average, gluten feed ration.	. . .	15.75	6	3.25	3.5	–
Average, Bibby's dairy cake ration.	. . .	15.75	6	3.25	–	3.5

It will be seen that the cows received the same basal ration daily, and in addition averaged 3.5 pounds of gluten feed or dairy cake.

Average Dry Matter and Digestible Organic Nutrients in Daily Ration (Pounds).

Ration.	Dry Matter.	Digestible Organic Nutrients.					Nutritive Ratio.
		Protein.	Fiber.	Extract Matter.	Fat.	Total.	
Gluten feed, average, .	24.99	2.36	4.15	7.73	.35	14.59	1: 5.4
Bibby's dairy cake, average.	24.91	2.07	3.96	7.27	.36	13.86	1: 6.0

The two rations furnished the same quantity of total dry matter daily. The Bibby's dairy cake ration contained rather less protein and about three-fourths of a pound less total digestible matter. This was due principally to the fact that Bibby's dairy cake was less digestible than the gluten feed. It would naturally be expected that Bibby's dairy cake ration would produce rather less milk, or cause the animals to shrink somewhat in live weight.

Total Yields of Milk Products (Pounds).

Ration.	Total Milk.	Average Daily Yield.	Total Solids.	Total Fat.	Butter Equivalent 85 Per Cent.
Gluten feed, ...	1,860.04	22.14	256.12	89.89	105.75
Bibby's dairy cake, . . .	1,830.01	21.79	251.20	90.00	105.88

The yields obtained from the two rations, covering a period of twenty-one days in each case, were practically identical. If the periods had covered twice the length of time, the results would have been regarded as more satisfactory. Longer periods were not practicable, owing to the condition of the animals and the nearness of summer weather.

Average Composition of the Herd Milk.

Ration.	Total Solids (Per Cent.).	Fat (Per Cent.).
Gluten feed, ...	13.77	4.83
Bibby's dairy cake, ...	13.73	4.92

The two rations produced milk having practically the same composition.

Food Cost of Milk Products.

Ration.	Total Milk.	One Hundred Pounds Milk.	One Pound Butter.
Gluten feed,	$20 85	$1 12	$0 20
Bibby's dairy cake,	22 03	1 20	21
Percentage increased cost with Bibby's dairy cake.	5.66	7.14	5.00

In calculating the above results, gluten feed was charged at $27.72 a ton, Bibby's dairy cake at $30, bran at $20, hay at $15 and rowen at $14. The increased cost of the milk and butter produced by the Bibby's dairy cake ration was due to the price asked for Bibby's dairy cake.

Herd Gain or Loss in Live Weight.

Ration.	Total Gain or Loss.
Gluten feed,	43 +
Bibby's dairy cake,	2 −

There appeared to have been a slight gain in live weight produced by the gluten ration. During the Bibby's dairy cake period the weight remained constant.

Conclusions.

1. Bibby's dairy cake, a manufactured product, resembles in chemical composition and digestibility standard wheat middlings. It has a sweet taste and an agreeable flavor and odor, due to the presence of the carob bean, fenugreek and salt.

2. It was found to contain slightly less digestible matter than middlings, and some 20 per cent. less than gluten feed. On the basis of digestible matter contained in the Bibby's dairy cake and in first-class gluten feed, the former should sell for 20 per cent. less a ton.

3. While the cake is readily eaten and highly relished by

all farm animals, it is believed that the agreeable flavor and odor do not make it worth the extra price asked.

4. In the feeding experiment, lasting twenty-one days, the four cows produced practically as much milk on the Bibby's dairy cake as on the gluten feed ration; the latter ration produced a slight gain in live weight. The cost of milk and butter was noticeably more on the Bibby's dairy cake ration. The experiment indicates that the Bibby's dairy cake ration furnished a sufficient quantity of digestible matter to meet the requirements of the several cows. Had the periods been longer, and the cows in a less advanced period of lactation, it is believed the differences would have been more striking.

5. Bibby's dairy cake, at prevailing market prices, is not regarded as an economical concentrate; it can be used, however, if desired, as the exclusive grain ration for sheep, young dairy stock and milch cows. From 5 to 8 pounds would be the usual daily allowance for the latter animals. Its chief use should be as an appetizer, to be mixed in small quantities with foods that, because of an inferior flavor, would not be otherwise readily consumed.

From the standpoint of economy, farmers will do well to produce their hay, silage and corn meal, and to purchase only those manufactured concentrates that are rich in protein, such as cotton-seed meal, gluten feed, distillers' and brewers' dried grains, wheat middlings and bran.

2. Eureka Silage Corn, — its Value for Massachusetts Farmers.

J. B. LINDSEY AND P. H. SMITH.

This corn is said to have originated in Virginia. It is a large southern dent, and is considerably used for silage purposes by New England farmers.

Brooks[1] of this station compared a number of dent varieties during the season of 1901. The Eureka grew to be 15 feet high, appeared to be quite heavily leaved, and when cut, September 14, the ears were just forming. This variety yielded rather heavier than the others, producing at the rate of 24 tons to the acre, containing 8,944 pounds of dry matter. Its digestibility was not determined. Brooks concluded that the heavy dents were not as satisfactory as the smaller varieties for New England conditions. At the solicitation of Ross Bros. of Worcester, who recommend and sell the Eureka seed for silage purposes, this department has made a more thorough study of the Eureka, and briefly presents the results and conclusions in the following pages.

Crop of 1903.

One-fourth acre of medium well-drained loam, in a good state of fertility, was treated with manure from well-fed dairy cows, at the rate of 6 cords to the acre. The manure was plowed in, and the land well fitted and seeded May 26, with Eureka corn, obtained of Ross Bros. The seed came up well, and the corn made as good growth as could be expected during the exceptionally cool season. Frosts held off until nearly the 1st of October, and the corn was allowed to grow until September 25, in order to insure a maximum

[1] Fourteenth annual report of the Hatch Experiment Station, pp. 32–34.

development. At that time it averaged 11½ feet in height, the ears had formed, and the kernels were just beginning to develop. When cut, it contained 82.6 per cent. of water, and yielded at the rate of 15 tons of green material to the acre.

Crop of 1904.

One-third of an acre of well-drained, light loam was plowed, manured at the rate of 6 cords to the acre and well fitted. The area was divided into two halves, and planted with Eureka and Sibley's Pride of the North corn, the latter a medium dent that will mature its seed in our latitude. Some of the seed failed to germinate, more particularly the Eureka, which necessitated some replanting. When the corn was 15 inches high it was thinned to about one stalk to the foot. The area was kept well cultivated and free from weeds. On July 12 the corn was growing fast and looked healthy, the Eureka being the taller. August 15 the Pride of the North was well tasseled and silked, while the Eureka tassels were just showing. The corn was cut September 15, at which time the Pride of the North averaged 9 to 10 feet in height and was fairly ripe, with kernels glazing. The Eureka was 12 to 13 feet high and quite immature, the ears being small and the kernels scarcely formed. Two plats, each 175 by 35 feet, were cut, stooked and eventually carried to the barn and carefully weighed. The Eureka yielded 936 pounds of dry matter, equal to 6,683 pounds per acre, equivalent to 20.4 tons of green corn (83.6 per cent. water); the Pride of the North yielded 877 pounds of dry matter, equal to 6,262 pounds per acre, equivalent to 13.9 tons of green corn (77.5 per cent. water).

Composition of Green Corn (Per Cent.).

	Eureka.		Pride of the North, 1904.
	1903.	1904.	
Water,	82.60	83.60	77.50
Ash,	1.08	1.08	1.05
Protein,	1.63	1.48	1.85
Fiber,	4.77	5.48	4.97
Nitrogen-free extract,	9.65	8.11	14.06
Fat,	.27	.25	.57
	100.00	100.00	100.00

The above analyses show that the Eureka, when cut in September, contained considerably more water and noticeably less nitrogen-free extract matter and fat than the Pride of the North.

Composition of Dry Matter (Per Cent.).

	Whole Plant.				Stover.		
	Eureka.			Pride of the North, 1904.	Eureka, 1904.	Pride of the North, 1904.	Average, Forty-one Analyses, for Comparison.
	1903.		1904.				
Ash,	6.19[1]	7.85[2]	6.58	4.67	6.96	6.77	6.60
Protein,	9.34	9.82	9.01	8.22	8.00	7.23	7.60
Fiber,	27.41	32.70	33.43	22.11	36.49	34.45	34.20
Extract,	55.52	47.90	49.47	62.47	47.19	50.01	50.20
Fat,	1.54	1.73	1.51	2.53	1.36	1.54	1.40
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[1] When cut in autumn. [2] After being housed in barn until March.

The differences in the composition are much more noticeable with the water eliminated. The Eureka (whole plant) contained decidedly more ash and fiber, rather more protein and much less extract matter than the Pride of the North.

The analyses show that the Pride of the North had reached a more advanced stage of development than the Eureka, and consequently contained a much larger proportion of starchy matter. The stover from the two varieties was quite similar in composition.

Percentage of Water in Field-cured Material.

Eureka.			Pride of the North.	
Whole Plant.		Stover.	Whole Plant.	Stover.
59.92[1]	68.92[2]	62.89[3]	37.84[4]	18.13[5]

[1] After being cured in barn for six months, 1903. [2] As it came from field, 1904.
[3] After being in barn about a month, 1904. [4] As it came from field, 1904.
[5] After being in barn about three months.

The field-cured Eureka still continued to contain a high moisture content, due probably to its immaturity and to its unusually coarse, porous stems.

The Pride of the North had about the usual water content for matured corn that had been field cured. These figures show that in a ton of dried Eureka fodder, as drawn to the barn, there would be 1,380 pounds of water and 620 pounds of dry matter; and in a ton of Pride of the North there would be 757 pounds of water and 1,243 pounds of dry matter; in other words, each ton of Pride of the North would have twice the feeding value of Eureka, without taking into consideration the superior nutritive character of the dry matter, which will be alluded to under another heading.

The corn stover derived from the two varieties likewise showed marked differences in the water percentage present. The barn-cured Pride of the North stover was exceptionally dry.

Composition of Parts of Corn (Per Cent.).

[Dry Matter.]

	Leaves.		Stalks.		Ears.		Husks.	
	Eureka.	Pride of the North.	Eureka.	Pride of the North.	Eureka.	Pride of the North.	Eureka.	Pride of the North.
Ash,	8.98	9.42	5.42	5.81	3.25	1.95	3.02	3.17
Protein,	14.53	14.53	4.80	4.55	12.00	9.82	8.66	5.40
Fiber,	28.43	25.00	35.77	31.94	19.47	11.37	24.64	27.32
Extract,	45.63	47.63	52.94	56.82	63.84	73.65	62.22	62.70
Fat,	2.43	3.42	1.07	.88	1.44	3.21	1.46	1.41
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The samples were taken immediately after the corn was cut (September 15), dried at a low heat, and preserved in glass-stoppered bottles. The leaves of the two varieties were similar in composition, and are the most valuable parts of the plant, aside from the ears. The stalks of the Eureka were characterized by containing more fiber than the other variety. The ears produced by the Eureka contained rather more protein and ash, decidedly more fiber and noticeably less fat and extract matter than those yielded by the Pride of the North. The analyses make clear that the ears obtained from the Eureka were quite imperfectly developed. The composition of the husks was more uniform.

Digestibility of the Corn.

The first digestion experiment was made in the autumn of 1903, with the Eureka green corn. Another experiment was made with the same corn, after it had been cured and housed for six months. Unfortunately, a digestion test was not made with the Pride of the North (whole plant). During the autumn of 1905, therefore, another sample of this variety was tested for digestibility. It was fully developed and well eared. Other experiments were made to test the digestibility of the stover of each of the two varieties produced in 1904. The several tests were made with the same sheep in each case, the results of which follow: —

	Eureka.		Pride of the North, Green, **1905** (Two Sheep).	Eureka, Stover, **1904** (Two Sheep).	Pride of the North, Stover, **1904** (Two Sheep).
	Green, **1903** (Three Sheep).	Dry, **1903** (Two Sheep).			
Dry matter,	67	64	71	54	54
Ash,	42	40	34	45	31
Protein,	67	57	63	48	45
Fiber,	60	72	65	59	60
Nitrogen-free extract,	72	64	77	53	54
Fat,	66	62	76	67	64

The green Eureka fodder (whole plant) and the same material dried showed only slight variation in the digestibility of total dry matter. The results correspond closely with those obtained by other experimenters with large southern varieties at a similar stage of growth. For some reason the fiber in the dry material was more fully digested than in the green substance, and the protein and extract matter less so. The Pride of the North (whole plant) proved to be rather more digestible than the Eureka, due to the fact that it was well eared. The digestible material in the Pride of the North, because of its content of matured grain, would naturally yield more net available energy than a like amount of digestible matter derived from the Eureka. The corn stover (all ears removed) from each of the two varieties appeared to be equally well digested.

Summary of Yields.

A definite quantity of each of the two varieties of green material was separated into husks, ears, leaves and stalks, in order to determine the relative proportions of each. The figures show percentages or pounds in 100.

(*a*) *Yield of Parts.*

Parts.	Eureka.			Pride of the North.		
	First Trial.	Second Trial.	Average.	First Trial.	Second Trial.	Average.
Husks,	6.50	8.00	7.25	10.25	11.25	10.75
Ears,	6.25	8.25	7.25	21.25	23.00	22.11
Leaves,	22.75	21.75	22.25	20.00	20.00	20.00
Stalks,	65.00	62.25	63.62	47.50	46.00	46.75
	100.50	100.25	100.37	99.00	100.25	99.67

The results are in accordance with the teaching of the analytical data. The Eureka showed only 7.25 per cent. of ears, while the Pride of the North contained 22.11 per cent. The Pride of the North variety consisted of 46.75 per cent. of stalks, and the Eureka 63.62 per cent. The Eureka, even at its less advanced stage of growth, contained only slightly more leafy matter than the Pride of the North.

(*b*) *Yield per Acre* (*Pounds*).

	Eureka.		Pride of the North, **1904.**
	1903.	**1904.**	
Green material,	30,000	40,800	27,800
Dry matter,	5,220	6,691	6,255
Estimated digestible matter,	3,497 [1]	4,483 [1]	4,441 [1]

[1] Obtained by allowing 67 per cent. of the dry matter to be digestible in the Eureka, and 71 per cent. in the Pride of the North, as determined by actual experiment.

The above results indicate strongly that the Eureka, although a larger variety, yielding considerable more green material than the Pride of the North, is not likely to furnish any more actual food to the acre. In the present instances, the party drawing the product of an acre of green Eureka corn to the barn would be transporting 34,109 pounds of water and 6,691 of dry matter, while in the case of the Pride of the North he would cart 21,545 pounds of water and 6,255 pounds of dry material; in other words, to secure essentially the same quantity of actual food in the Eureka he would be required to handle 12,564 pounds extra water.

It is, of course, understood that the yield would vary from year to year, depending on soil and climatic conditions. It is believed, however, that the relative proportions would hold true, and that the farmer would secure as much actual food material from those varieties of corn that mature their seed, without being obliged to handle the extra bulk in the form of water.

Conclusions.

1. Eureka silage corn is a late dent variety; it has large stalks, which appear to be thickly set with leaves. During the seasons of 1903 and 1904 it grew 11 to 13 feet high, and when cut, September 15, the ears were very immature (kernels just forming).

2. In comparison with Sibley's Pride of the North, a medium dent, which matures its ears in this latitude, the Eureka green corn, when cut, contained about 6 per cent. more water, noticeably more ash and fiber, and much less extract matter. The field-cured fodder of the Eureka still contained as high as 69 per cent. of water, while the Pride of the North contained only 38 per cent.

3. The leaves and husks of each variety did not vary greatly in composition. The ears and stalks of the Eureka contained more fiber and much less extract matter and fat than those of the Pride of the North.

4. The Eureka green fodder was found to be 67 per cent., and the same material dry 64 per cent., digestible; a typical sample of Pride of the North, cut green, was 71 per cent. digestible. The stover of both varieties proved equally digestible.

5. The Eureka yielded about the same relative weight of green leaves as did the Pride of the North. It produced 64 per cent. of stalks and 7 per cent. of ears, while the Pride

of the North yielded 47 per cent. of stalks and 22 per cent. of ears.

6. The Eureka produced at the rate of 20 tons of green fodder, and the Pride of the North 13 tons of green fodder, to the acre. The latter, however, contained nearly as much dry and digestible matter (actual food material) as did the former. The excess yield of Eureka green corn, therefore, consisted of water.

7. Had the seasons of 1903 and 1904 been more favorable to the growth of corn, it is probable that both varieties would have produced larger yields. It is very doubtful, however, if the Eureka would have matured its grain.

The writer, therefore, thinks it unwise to grow such late dents as the Eureka, and believes the northern farmer will secure better feed for less money by holding fast to those varieties that will mature not later than September 10 or 15.

It is well known that immature corn, such as the Eureka, undergoes more serious decomposition when ensiled than do well-matured varieties, which would still further detract from its nutritive value.

3. Concerning Wheat Bran.

J. B. LINDSEY.[1]

(1) *Introduction.*

Until within comparatively recent times, wheat bran and corn meal have formed the two staple concentrated feeds for dairy stock, and in spite of the large variety of concentrates now in the market, the former still continues to be used largely by the great majority of dairymen in our eastern States. The reasons for this are not difficult to find. A good quality of bran is uniformly palatable; it can be fed in considerable quantities without producing any ill effects; it acts as a slight laxative; it furnishes more digestible protein than corn; and it serves as a very satisfactory diluter or distributer of the heavy concentrates, such as the glutens, cotton-seed meal and flour middlings. It is believed, however, that the nutritive material contained in bran can be purchased more cheaply in other concentrates, and that New England farmers often use more of it than economy warrants.

Attention is called in the present paper to the composition, digestibility, cost of digestible matter and the fertilizer ingredients in bran, as compared with other concentrated feeds, and likewise to experiments I. and II., in which corn silage is compared with wheat bran as a distributer of the heavy concentrates. Note particularly the brief discussion of the results, at the end of the article.

[1] With E. B. Holland, P. H. Smith and J. G. Cook.

(2) *Average Composition of Concentrates.*

Ingredients.	Wheat Bran.	For Comparison.				
		Cotton-seed Meal.	Gluten Feed.	Distillers' Dried Grains.	Brewers' Dried Grains.	Malt Sprouts.
Water,	10.00	7.00	8.50	8.00	8.00	11.00
Ash,	6.40	6.50	1.70	1.70	3.80	5.80
Protein,	16.00	45.10	26.50	33.00	23.10	27.10
Fiber,	10.00	6.10	7.20	13.10	10.80	11.80
Extract matter (starchy),	53.00	24.20	53.10	32.40	49.40	42.90
Fat,	4.60	11.10	3.00	11.80	4.90	1.60

Wheat bran contains noticeably less protein than any of the other important by-products. Nitrogen-free extract matter usually is the fodder group next in value to the protein. The quantity contained in bran is approximately equal to that found in gluten feed, and not greatly in excess of the percentage in brewers' grains and malt sprouts.[1] Most of the several feeds enumerated contain about similar fiber percentages.

(3) *Digestibility of the Concentrates.*

The figures in the following table show the pounds of digestible fodder groups contained in one ton of the several feeds.

Wheat bran is shown to contain rather less total digestible matter and noticeably less digestible protein than any of the several feeds tabulated. The two carbohydrate feeds, corn and hominy meals, are naturally deficient in protein, but very rich in digestible starchy matter and fat.

[1] The quantity of extract matter in cotton-seed meal is quite small, due to the exceptionally high protein percentage.

Organic Matter digestible in 2,000 Pounds.

Ingredients.	Wheat Bran.	Cotton-seed Meal.	Gluten Feed.	Brewers' Dried Grains.	Malt Sprouts.	Distillers' Dried Grains.	Corn Meal.	Hominy Feed.
Protein,	254	800	440	364	434	448	130	142
Fiber,	58	68	110	114	78	160	-	44
Extract matter,	732	298	964	574	580	520	1,328	1,110
Fat,	60	196	50	90	32	206	60	152
Totals,	1,104	1,362	1,564	1,142	1,124	1,334	1,518	1,448

Retail Cost of One Pound of Digestible Matter.

	Spring and Winter Bran. 1901 to 1904.	Cotton-seed Meal. 1901 to 1904.	Gluten Feed. 1901 to 1904.	Distillers' Dried Grains. 1904 to July, 1905.	Brewers' Dried Grains. 1904.	Malt Sprouts. 1904 to July, 1905.	Corn Meal. 1901 to 1904.	Hominy Meal. 1901 to 1904.
Market price per ton,	$22 48	$29 17	$26 05	$27 00	$22 50	$21 00	$26 12	$25 03
Cost of one pound of digestible matter (cents),	2.04	2.15	1.67	2.03	1.97	1.87	1.70	1.72

The above figures are quite instructive. They show that digestible matter in bran, cotton-seed meal and distillers' and brewers' dried grains has cost about the same for a number of years, while in the form of malt sprouts the price has been somewhat less.[1] Corn and corn by-products (gluten and hominy feed) have furnished digestible matter for uniformly less money than it could be purchased for in the form of either bran, cotton-seed meal, distillers' or brewers' residues.

Retail Cost of Digestible Protein.

[Allowing 1 cent for digestible carbohydrates, .5 cent for digestible fiber and 2.25 cents for digestible fat.]

	Spring and Winter Bran. 1901 to 1904.	Cotton-seed Meal. 1901 to 1904.	Gluten Feed. 1901 to 1904.	Distillers' Grains. 1904 to July, 1905.	Brewers' Grains. 1904.	Malt Sprouts. 1904.
Market price per ton, .	$22 48	$29 17	$26 05	$27 00	$22 50	$21 00
Cost of one pound of digestible protein (cents).	5.40	2.72	3.00	3.65	3.91	3.25

Cotton-seed meal furnishes digestible protein for the least money, gluten feed standing next in order, while protein in the form of wheat bran is decidedly expensive. Naturally, carbohydrate feeds, corn and the like, are not economical sources of protein.

(4) *Fertilizing Ingredients in a Ton of Concentrates.*

	Wheat Bran.	Cotton-seed Meal.	Gluten Feed.	Distillers' Grain.	Brewers' Grains.	Malt Sprouts.
Nitrogen, ...	51	144	85	106	74	86
Potash, ...	28	37	-	-	17	33
Phosphoric acid, . .	42	50	7	60	21	29
Valuation per ton, . .	$12 34	$30 18	$16 00	$19 78	$15 25	$18 47
Percentage valuation of retail cost.	54	103	62	73	68	88

Bran is quite rich in the mineral ingredients phosphoric acid and potash, being exceeded only by cotton-seed meal.

[1] The retail price of malt sprouts and brewers' dried grains has been rather difficult to ascertain, for the reason that comparatively small quantities are sold in Massachusetts markets.

The corn by-products (gluten feed and distillers grains) contain only a trace of potash. The money valuations are based on current market prices, namely: nitrogen, 18.5 cents; potash, 4.25 cents; and phosphoric acid, 4 cents a pound. The fertilizing elements in the several feeds are in as desirable a form as those in the best grades of unmixed fertilizing stock. Bran is shown to contain fertilizer ingredients equal to 54 per cent. of its cost, and cotton-seed meal is fully equal to its cost; the others are considerably in excess of the bran.

It is not to be inferred that after the several feeds have passed through the animal their fertilizing ingredients have as high a money value as before they were consumed. In fact, some 20 per cent. has been retained by the animal, more or less loss has unavoidably occurred in the manurial residue, and they are in a much more bulky condition, which requires considerable additional labor to apply them. Nevertheless, the figures show clearly that the combined fertilizer ingredients in bran have noticeably less value than in any of the other by-products.

Conclusions.

1. Wheat bran contains noticeably less total as well as less digestible protein than any of the other nitrogenous by-products.

2. The total digestible matter in bran is likewise less than in the other prominent concentrates; thus, cotton-seed meal contains 24 per cent. more, gluten feed 44 per cent., distillers' grains 21 per cent. and corn meal 38 per cent.

3. For several years past the cost of a pound of digestible matter in bran, cotton-seed meal, distillers' and brewers' dried grains has been about the same; it could be purchased in the form of gluten feed, corn and hominy meals for some 20 per cent. less.

4. A pound of digestible protein in wheat bran cost 100 per cent. more than in cotton-seed meal, 80 per cent. more than in gluten feed and 50 per cent. more than in distillers' dried grains.

5. Because of its relatively low protein percentage, the

fertilizer ingredients in bran have from 10 to 50 per cent. less money value than those contained in the other by-products.

6. The nutritive material and especially the protein contained in wheat bran must be regarded, therefore, as relatively expensive. Because of its palatability, its laxative effect and its desirability as a diluter or distributer of the heavy concentrates, it will continue to be used by many farmers as a portion of the grain ration for dairy stock. See practical deductions as to the use of bran, on page 114.

(5) *Wheat Bran* v. *Corn Silage as a Distributer of the Heavy Concentrates.*

EXPERIMENT I. SPRING, 1903.

Object of the Experiment. — Wheat bran has been shown to be an expensive feed, judged solely from the amount of nutritive material it contains. The present experiment was undertaken to see if silage would not serve as a distributer equally as well as bran. Such being the case, the farmer could use *home-grown* corn, or corn and cob meal, in place of an equal amount of bran, and, by feeding in addition a few pounds daily of cotton-seed meal and malt sprouts or flour middlings, get along with a minimum quantity of *purchased* grain.

Plan of the Experiment. — The cows, ten in number, were high-grade Jerseys. Eight had calved early the previous autumn, and two, Pearl and Red 2d, the preceding December.

The animals were divided as equally as possible into two lots of five each, and both herds fed for two weeks upon the so-called bran ration, consisting of silage, hay, cotton-seed meal, flour middlings and wheat bran. In the second period, lasting five weeks, one lot of cows, known as Herd I., continued to receive the same ration; and the other lot, Herd II., was fed the so-called silage ration, consisting of silage and hay, cotton-seed meal, flour middlings and corn and cob meal. In each of the two periods one week was considered preliminary.

In interpreting the results, it is proposed to note the weekly yields produced in the second period by both herds on different grain rations, as compared with the weekly yields of the first periods, when the two herds received the same grain ration, thus ascertaining the comparative efficacy of the two different grain rations fed in the second period. The yields obtained in the first period are to be used simply as a basis for comparison.

Duration of the Experiment.

Period I.

Herd.	Character of Ration.	Cows.	Date.	Number of Weeks.
I., .	Bran as distributer,	Brighty, Pearl, Linnie, Roda, Doliska.	March 30[1]-April 5.	1
II., .	Bran as distributer,	Red II., Dora, Blanche, May, Daisy.	March 30-April 5.	1

Period II.

Herd.	Character of Ration.	Cows.	Date.	Number of Weeks.
I., .	Bran as distributer,	Brighty, Pearl, Linnie, Roda, Doliska	April 12[1]-May 10.	4
II., .	Silage as distributer,	Red II., Dora, Blanche, May, Daisy.	April 12-May 10.	4

[1] Preceded by preliminary period of seven days.

General Care of the Animals. — The experiment was carried out in the station barn, especially set apart for such work. Each animal was kept in a roomy stall, well carded, and turned daily into a yard for exercise. The cows were in good condition, and quite contented.

Method of Feeding. — The cows were fed twice daily, and water was before them constantly. In case of the bran ration, the several grains composing it were carefully mixed, and fed just before milking. The grains used in the silage ration — cotton-seed and corn meals and flour middlings — were likewise mixed, and the resulting combination quite thoroughly mingled with the silage by means of a four-tined fork, and fed previous to milking. One quart of the bran ration weighed .80 of a pound, and 1 quart of the grain ration fed with the silage weighed 1.4 pounds, the former being naturally much more bulky.

Character of the Feed Stuffs. — The bran was from spring wheat, the other grains were of the usual good quality. The silage, made from rather poorly eared corn, was of average quality. The hay was largely Kentucky blue-grass, with some clover.

Weighing the Animals. — The animals were weighed on three consecutive days at the beginning and end of the second period.

Sampling Feeds. — The coarse fodders were sampled three times during the second period, dry matter determinations made immediately, and composite samples analyzed. Small samples of the grains were taken daily and placed in glass-stoppered bottles.

Sampling Milk. — The milk of each cow was sampled twice daily for five consecutive days of each week of the two periods, and preserved with formaline in tightly corked bottles. The method of sampling consisted in mixing the freshly drawn milk with an especially constructed mixer, and immediately removing a small dipper full.

Average Ration consumed by Each Cow Daily (Pounds).

First period: both herds, bran ration.

Herd.	First Cut Hay.	Silage.	Bran.	Cotton-seed Meal.	Flour Middlings.	Corn and Cob Meal.
I., . . .	12.52	26.10	3.60	2.00	2.00	-
II., . . .	13.60	29.00	3.80	2.10	2.10	-
Second period: Herd I., bran ration; Herd II., silage ration.						
I., . . .	12.80	25.70	3.60	2.00	2.00	-
II., . . .	13.60	29.00	-	2.10	2.10	3.80

Herd I. received practically the same quantity of grain and roughage daily in each period; the same can be said of Herd II. Herd II. needed and received slightly more than Herd I. during both periods.

Average Dry and Digestible Daily Nutrients consumed by Each Cow (Pounds).

Herd I.: both periods, bran ration.

Period.	Dry Matter.	Protein.	Carbo-hydrates.	Fat.	Total.	Nutritive Ratio.
I., . . .	22.98	2.42	11.38	.69	14.49	1:5.4
II., . . .	23.16	2.43	11.46	.69	14.58	1:5.4
Herd II.: first period, bran ration; second period, silage ration.						
I., . . .	24.85	2.58	12.36	.74	15.68	1:5.4
II., . . .	24.78	2.26	13.29	.73	16.28	1:6.5

Herd I. received the same quantity of digestible nutrients during both periods. Herd II. received more total digestible matter in the first period than did Herd I., but the nutritive ratio of the fodder groups was the same. In the second or silage period Herd II. consumed rather more total digestible nutrients than in the first period, but less digestible protein, the nutritive ratio being somewhat wider (1 : 6.5, instead of 1 : 5.4). This increase of digestible matter consumed was due to the higher digestibility of the corn and cob meal.

Weight of Animals at Beginning and End of Second Period (Pounds).

Herd.		Brighty.	Pearl.	Linnie.	Roda.	Doliska.	Red II.	Dora.	Blanche.	May.	Daisy.	Gain or Loss.
I., .	Beginning, .	850	958	815	860	761	-	-	-	-	-	+67
	End, . .	874	967	828	864	778	-	-	-	-	-	
II., .	Beginning, .	-	-	-	-	-	1,003	875	1,168	1,048	850	+94
	End, . .	-	-	-	-	-	1,003	905	1,177	1,076	877	

Each herd made a slight gain during the period. The difference is unimportant.

Yield of Milk and Milk Ingredients (Pounds).

First period: both herds, bran ration.

Herd.	Cows.	Total Milk.	Daily for Cow.	Total Solids.	Total Fat.	Butter Equivalent (85 Per Cent.).
I.	Brighty	127.25	18.18	20.06	8.21	9.66
	Pearl	218.00	31.14	29.89	10.90	12.82
	Linnie	157.00	22.43	22.62	8.48	9.98
	Roda	110.74	15.82	15.32	5.65	6.65
	Doliska	184.99	26.43	23.29	7.03	8.27
Total		797.98	114.00	111.18	40.27	47.38
II.	Red II.	262.49	37.50	32.31	11.02	12.96
	Dora	142.60	20.37	20.29	7.27	8.55
	Blanche	150.62	21.52	22.61	7.91	9.31
	May	139.50	19.93	21.41	7.88	9.27
	Daisy	123.00	17.57	19.45	7.38	8.68
Total		818.21	116.89	116.07	41.46	48.77

Second period: Herd I., bran ration; Herd II., silage ration.

Herd.	Cows.	Total Milk.	Daily for Cow.	Total Solids.	Total Fat.	Butter Equivalent (85 Per Cent.).
I.	Brighty	509.74	18.21	80.84	32.41	38.13
	Pearl	879.70	31.42	125.70	46.44	54.65
	Linnie	679.00	24.25	97.84	36.60	43.06
	Roda	439.82	15.71	62.37	22.17	26.08
	Doliska	773.21	27.61	97.73	29.15	34.30
Total		3,281.47	117.20	464.48	166.77	196.22
II.	Red II.	1,048.58	37.45	131.91	43.62	51.32
	Dora	581.83	20.78	85.65	31.48	37.04
	Blanche	609.73	21.78	92.25	32.01	37.66
	May	497.49	17.77	78.11	27.96	32.89
	Daisy	480.68	17.17	77.53	29.99	35.28
Total		3,218.31	114.95	465.45	165.06	194.19

Average Weekly Yields of Each Herd (Pounds), and Percentage Gain or Loss.

Herd I.

Periods.	Milk.	Solids.	Fat.	Butter Equivalent (85 Per Cent.).
I., ...	798.0	111.2	40.3	47.4
II., ...	820.4	116.1	41.7	49.1
Percentage gain or loss, II. over I.,	+2.8	+4.4	+3.5	+3.6

Herd II.

Periods.	Milk.	Solids.	Fat.	Butter Equivalent (85 Per Cent.).
I., ...	818.2	116.1	41.5	48.8
II., ...	804.6	116.4	41.3	48.5
Percentage gain or loss, II. over I.,	−1.7	+.3	−.4	−.6

It will be seen that Herd I., which received the bran ration during both periods, made a slight gain during the second period in the quantity of milk and milk ingredients; while Herd II., which received the silage ration in the second period, underwent a slight loss. The differences are so slight as to prevent any positive conclusions. They indicate, however, that the bran ration produced slightly better results than the silage ration, due possibly to the excess of protein in the former ration.

Dry and Digestible Matter required to produce Milk, Milk Solids and Milk Fat.

Herd I.: both periods, bran ration.

Period.	Dry Matter required to produce —			Digestible Matter required to produce —		
	One Hundred Pounds Milk.	One Pound Solids.	One Pound Fat.	One Hundred Pounds Milk.	One Pound Solids.	One Pound Fat.
I., ...	100.80	7.23	19.97	63.56	4.56	12.60
II., ...	98.81	6.98	19.44	62.21	4.40	12.24

Herd II : first period, bran ration; second period, silage ration.

Period.	One Hundred Pounds Milk.	One Pound Solids.	One Pound Fat.	One Hundred Pounds Milk.	One Pound Solids.	One Pound Fat.
I., ...	106.32	7.49	20.98	67.04	4.73	13.23
II., ...	107.78	7.45	21.01	70.83	4.90	13.81

Herd I. required slightly less dry and digestible matter to make milk and milk ingredients in the second period. Herd II. took a little more dry and digestible matter in the second period to make a definite quantity of milk, milk solids and milk fat. On the basis of the above figures, it may be concluded that the bran ration produced a trifle better results than the silage ration.

Food Cost of Milk and Butter.

Herd I.: both periods, bran ration.

Period.	One Hundred Pounds Milk.	One Hundred Pounds Butter.
I,	$1 03	$17 33
II.,	1 01	16 81

Herd II.: first period, bran ration; second period, silage ration.

Period.	One Hundred Pounds Milk.	One Hundred Pounds Butter.
I.,	$1 08	$18 11
II.,	1 13	18 74
Percentage increased cost, Period II. over Period I.	+4.6	+3.5

The cost of milk and butter is based upon hay at $15 a ton, silage at $3.50, bran at $22, corn and cob meal at $26, cotton-seed meal at $30 and middlings at $25. The cost of milk and butter produced by Herd I. in both periods was nearly identical, and the slight variations may be attributed to experimental error. The increased cost of the milk and butter produced by Herd II. in the second period was due largely to the then existing excess cost of the corn and cob meal over that of the bran, and not to the feeding effect of the two rations.

Fertilizer Ingredients in Rations (Cost).

First period: Herd I., bran ration.

19.46 pounds nitrogen, valued at	$3 31
13.81 pounds potash, valued at	69
7.75 pounds phosphoric acid, valued at	31
Total,	$4 31

Fertilizer Ingredients, etc. — Concluded.

First period: Herd II., bran ration.

20.90 pounds nitrogen, valued at	$3 55
14.98 pounds potash, valued at	75
8.26 pounds phosphoric acid, valued at . . .	33
Total, ...	$4 63

Second period: Herd I., bran ration.

78.16 pounds nitrogen, valued at	$13 29
55.65 pounds potash, valued at	2 78
31.02 pounds phosphoric acid, valued at . . .	1 24
Total, ...	$17 31

Second period: Herd II., silage ration.

78.38 pounds nitrogen, valued at	$13 32
54.89 pounds potash, valued at	2 74
24.86 pounds phosphoric acid, valued at . . .	99
Total, ...	$17 05

The total quantity and valuation of fertilizer ingredients were nearly identical in each ration.

Conclusions.

1. The animals were in good condition during the entire experiment, hence the silage proved equally as satisfactory as bran for distributing the heavy concentrates (cotton-seed meal and flour middlings).

2. The so-called bran ration produced a trifle more milk and milk ingredients than did the silage ration. Furthermore, it required a little less dry and digestible matter to make a definite quantity of milk ingredients with the former ration.

3. It cost several per cent. more to produce milk with the silage ration; but this difference was due primarily to the temporarily increased market price of the corn and cob meal, and not to the feeding effect of the ration.

Experiment II. — Winter, 1904.

Object of the Experiment. — The object of this experiment was quite similar to the one already described; namely, to see if corn silage could not be employed in place of wheat bran as a distributer of the heavy concentrates.

Plan of the Experiment. — This experiment was conducted on the reversal plan. The cows were divided into two lots of four each. In the first half of the experiment one lot received the so-called bran ration at the same time the other lot received the silage ration. In the second half these conditions were reversed.

Duration of Experiment.

First Half.

Character of Ration.	Date.	Number of Weeks.	Cows.
Bran as distributer, . . .	January 16 through February 26.	6	Blanche, Brighty, Doliska, Dora.
Silage as distributer, . . .	January 16 through February 26.	6	Daisy, Linnie, May, Roda.

Second Half.

Character of Ration.	Date.	Number of Weeks.	Cows.
Bran as distributer, . . .	March 5 through April 15.	6	Daisy, Linnie, May, Roda.
Silage as distributer, . . .	March 5 through April 15.	6	Blanche, Brighty, Doliska, Dora.

Care of Animals and of the Product. — The general care of the animals and the method of feeding and of sampling the milk have been described in the preceding experiment. Each cow was weighed for three consecutive days at the beginning and end of each half of the experiment, the weighing being done in the afternoon before feeding and watering.

Character of the Feeds. — The weights of a quart of the two grain mixtures were about the same as those fed in the former experiment, the bran ration being much the more bulky. The bran was derived from winter wheat, and was light and flaky. Corn meal was used in place of corn and cob meal, the latter not being available. The cotton-seed meal and flour middlings were of the usual good quality.

The silage was largely corn, with a slight admixture of soy beans. The corn and soy beans were grown together, but, owing to the cool summer of 1903, the beans made a very light growth and produced scarcely any seeds. The corn, likewise, was poorly eared, and the total yield of the mixture was only about 8 tons to the acre. The silage was not at all decomposed or unduly acid, and was considered of fair quality. The hay was largely Kentucky blue-grass, of good quality, cut when in full to late blossom.

Rations consumed Daily (Pounds).

Wheat Bran Ration.

Cows.	First Cut Hay.	Silage.	Bran.	Corn Meal.	Flour Middlings.	Cotton-seed Meal.
Blanche,	16.0	34.6	3.5	-	2.0	1.5
Brighty,	13.0	30.0	3.0	-	2.0	1.0
Doliska,	12.0	30.0	3.0	-	2.0	1.0
Dora,	13.0	30.0	3.0	-	2.0	1.0
Daisy,	13.0	30.0	3.0	-	2.0	1.0
Linnie,	15.0	30.0	3.0	-	2.0	1.0
May,	16.0	30.0	3.0	-	2.0	1.0
Roda,	12.0	30.0	3.0	-	2.0	1.0
Average,	13.8	30.6	3.1	-	2.0	1.1

Silage Ration.

Cows.	First Cut Hay.	Silage.	Bran.	Corn Meal.	Flour Middlings.	Cotton-seed Meal.
Blanche,	15.0	35.0	-	3.0	2.0	2.0
Brighty,	12.0	30.0	-	2.5	2.0	1.5
Doliska,	11.0	28.1	-	2.2	2.0	1.4
Dora,	12.0	30.0	-	2.5	2.0	1.5
Daisy,	12.0	30.0	-	2.5	2.0	1.5
Linnie,	14.0	30.0	-	2.5	2.0	1.5
May,	14.0	26.9	-	2.3	1.8	1.4
Roda,	11.0	30.0	-	2.5	2.0	1.5
Average,	12.6	30.0	-	2.5	2.0	1.5

Dry and Digestible Matter in Daily Rations (Pounds).

Wheat Bran Ration.

Cows.	Dry Matter.	Digestible Organic Nutrients.					Nutritive Ratio.
		Protein.	Fiber.	Extract Matter.	Fat.	Total.	
Blanche, . . .	27.12	2.54	4.36	8.45	.63	15.98	1:5.6
Brighty, . . .	22.66	2.09	3.61	7.21	.53	13.44	1:5.7
Doliska, . . .	21.78	2.04	3.43	6.98	.52	12.97	1:5.7
Dora, ...	22.66	2.09	3.61	7.21	.53	13.44	1:5.7
Daisy, ...	22.66	2.09	3.61	7.21	.53	13.44	1:5.7
Linnie, ...	24.44	2.18	3.97	7.67	.54	14.36	1:5.9
May, ...	25.33	2.23	4.15	7.89	.55	14.82	1:6.0
Roda, ...	21.78	2.04	3.43	6.98	.52	12.97	1:5.7
Average, . .	23.55	2.16	3.77	7.45	.54	13.92	1:5.7

Silage Ration.

Cows.	Dry Matter.	Protein.	Fiber.	Extract Matter.	Fat.	Total.	Nutritive Ratio.
Blanche, . . .	26.28	2.46	4.15	9.03	.68	16.32	1:5.9
Brighty, . . .	21.76	2.03	3.40	7.60	.57	13.60	1:6.0
Doliska, . . .	20.15	1.90	3.14	7.03	.53	12.60	1:6.0
Dora, ...	21.76	2.03	3.40	7.60	.57	13.60	1:6.0
Daisy, ...	21.76	2.03	3.40	7.60	.57	13.60	1:6.0
Linnie, ...	23.53	2.13	3.76	8.06	.58	14.53	1:6.2
May, ...	22.49	2.00	3.63	7.61	.54	13.78	1:6.2
Roda, ...	20.87	1.99	3.22	7.38	.56	13.15	1:6.0
Average, . .	22.33	2.07	3.51	7.74	.58	13.90	1:6.0

Average Daily Rations (Pounds).

Character of Rations.	Hay.	Silage.	Bran.	Corn Meal.	Flour Middlings.	Cotton-seed Meal.
Bran, ...	13.8	30.6	3.1	–	2.0	1.1
Silage, ...	12.6	30.0	–	2.5	2.0	1.5

Average Dry and Digestible Nutrients in Daily Rations (Pounds).

Character of Ration.	Dry Matter.	Digestible Organic Nutrients.				Nutritive Ratio.
		Protein.	Carbo-hydrates.	Fat.	Total.	
Bran, ...	23.55	2.16	11.22	.54	13.92	1:5.7
Silage, ...	22.33	2.07	11.25	.58	13.90	1:6.0

The average daily bran ration, consisting approximately of 14 pounds of hay, 31 pounds of silage (about a bushel), 3 pounds of bran, 2 pounds of flour middlings and 1 pound of cotton-seed meal, may be considered a good type of a dairy ration, and quite similar to combinations in use by many milk producers who buy all of their grain. It was the aim in preparing the silage ration to do away with the bran by substituting home-grown corn, and at the same time to produce a combination that would contain essentially the same quantity and proportion of digestible nutrients. This was accomplished by feeding 2.5 pounds of corn meal instead of 3 pounds of bran, and 1.5 pounds of cotton-seed meal in place of the 1 pound fed in the bran ration.

Assuming that the farmer produced the hay, silage and corn meal in the ration, he would only use 3.5 pounds daily of purchased grain, costing 4.7 cents, while the bran ration would require a daily cash outlay for grain of 7.25 cents.

The two rations contained almost identical quantities of digestible protein and of total digestible nutrients. Both rations appeared to be equally well relished by the animals. The entire herd consumed the bran ration without the least irregularity, while on the silage ration the cow May suffered an attack of indigestion which caused her to shrink noticeably in her milk, and rendered it necessary to reduce her feed for some ten days. Whether this disturbance may be attributed to the character of the ration, or to other causes, it is difficult to state with certainty. Cow Doliska, while receiving the silage ration, underwent an attack of mammitis in one quarter of the udder, which decreased her milk yield, and made it necessary to take away temporarily a considerable portion of her grain ration. This cow was producing a large yield of milk during the experiment, but was not in first-class physical condition. It seems probable that her condition rendered her sensitive to the combination of heavy grain, even though it was distributed through the silage.

Weight of Animals at Beginning and End of Experiment (Pounds).

Wheat Bran Ration.

	Blanche.	Brighty.	Doliska.	Dora.	Daisy.	Linnie.	May.	Roda.	Total Gain or Loss.
Beginning,	1,176	832	753	887	842	841	1,020	852	+29
End,	1,146	841	741	876	863	854	1,024	887	

Silage Ration.

	Blanche.	Brighty.	Doliska.	Dora.	Daisy.	Linnie.	May.	Roda.	Total Gain or Loss.
Beginning,	1,121	838	714	868	823	828	1,013	831	+18
End,	1,133	836	720	884	830	823	990	838	

The animals practically maintained their weight on each of the rations.

Yield of Milk and Milk Ingredients, with Percentage Gain or Loss (Pounds).

Wheat Bran Ration.

Cows.	Total Milk.	Daily Milk.	Total Solids.	Total Fat.	Butter Equivalent. ⅙ added.
Blanche,	1,004.08	23.91	145.19	51.51	60.10
Brighty,	790.62	18.82	122.39	49.73	58.02
Doliska,	1,105.37	26.32	134.97	40.24	46.95
Dora,	909.16	21.65	126.10	44.28	51.66
Daisy,	715.10	17.03	110.05	41.48	48.39
Linnie,	914.35	21.77	130.57	48.92	57.07
May,	834.73	19.87	123.54	43.99	51.32
Roda,	834.03	19.86	115.93	39.95	46.61
Totals,	7,107.44	21.15	1,008.74	360.10	420.12

Silage Ration.

Cows.	Total Milk.	Daily Milk.	Total Solids.	Total Fat.	Butter Equivalent. ⅙ added.
Blanche,	1,009.62	24.04	145.79	50.99	59.49
Brighty,	790.06	18.81	123.88	50.25	58.63
Doliska,	909.17	21.65	114.28	34.55	40.31
Dora,	874.78	20.83	125.01	44.44	51.85
Daisy,	798.06	19.00	123.14	46.13	53.82
Linnie,	997.35	23.75	141.82	52.86	61.67
May,	836.97	19.93	126.55	46.28	53.99
Roda,	930.92	22.16	126.42	43.19	50.39
Totals,	7,146.93	21.27	1,026.89	368.69	430.15
Percentage gain of silage over bran ration.	0.5	-	1.7	2.2	-

The yields are slightly in favor of the silage ration, but the differences are so small as to have no particular significance. Had cows May and Doliska remained undisturbed during the experiment, this increased yield would have been more pronounced.

Average Composition of Herd Milk (Per Cent.).

Character of Ration.	Total Solids.	Fat.	Solids not Fat.
Wheat bran, ...	14.19	5.07	9.12
Silage, ...	14.37	5.16	9.21

While the results show that the silage ration produced milk a trifle richer in both fat and solids not fat, the slight difference is without any important signification.

Dry and Digestible Matter required to produce Milk and Milk Ingredients (Pounds).

Character of Ration.	Dry Matter.			Digestible Matter.		
	One Hundred Pounds Milk.	One Pound Solids.	One Pound Fat.	One Hundred Pounds Milk.	One Pound Solids.	One Pound Fat.
Wheat bran, ...	111.35	7.85	21.98	65.84	4.64	13.00
Silage, ...	104.96	7.31	20.35	65.33	4.55	12.67

While the results show that in case of the silage ration it required a little less *dry matter* to produce a definite quantity of milk and butter fat, they also show that in case of both rations practically the *same quantity of digestible matter* was necessary to produce an equal quantity of milk products.

Food Cost of Milk Products.

Character of Ration.	Total Milk.	One Hundred Pounds Milk.	One Quart Milk (Cents).[1]	One Pound Butter (Cents)
Wheat bran, ...	$77 76	$1 09	2.45	18.5
Silage, ...	75 42	1 06	2.38	17.5
Percentage increased cost of bran over silage ration.	3.1	2.8	2.9	5.8

[1] 2.25 pounds is the commercial figure allowed for one quart of milk; the theoretical quantity is 2.15 pounds, the excess of .10 of a pound being allowed for loss in handling.

With hay at $15 a ton, silage at $3.50, bran at $22, corn meal at $24, cotton-seed meal at $28 and middlings at $26, the silage ration produced milk and butter slightly cheaper than did the bran ration. This difference in cost is due partly to the temporary variation in the cost of the several grains, and partly to the slightly more favorable effect of the silage ration.

Approximate Fertilizer Ingredients in Rations (Cost).

Wheat Bran Ration.

172.29 pounds nitrogen, valued at	$30 15
134.92 pounds potash, valued at	5 40
68.04 pounds phosphoric acid, valued at	2 72
Total,	$38 27

Silage Ration.

169.99 pounds nitrogen, valued at	$29 69
119.77 pounds potash, valued at	4 79
54.88 pounds phosphoric acid, valued at	2 20
Total,	$36 68

The total rations consumed by the herd contained nearly the same quantity of plant food. There was a slight excess of potash and phosphoric acid in the bran ration, due to the richness of the bran in these two mineral constituents.

Conclusions.

1. The silage ration produced slightly more milk and milk ingredients at a trifle less cost than did the bran ration.

2. A little less dry and digestible matter was required to produce a given quantity of milk products with the former ration.

3. Two animals were temporarily out of condition while receiving the silage ration. This may have been partly due to the effects of the heavy concentrates and partly to other causes.

Discussion of Results.

1. In both experiments hay and corn silage served as the roughage, while a mixture of cotton-seed meal, flour middlings and bran, or cotton-seed meal, flour middlings and

corn meal or corn and cob meal, served as the two grain rations; bran acted as a diluter of the heavy concentrates in one case, and corn silage in the other.

2. In the first experiment the results were slightly favorable to the bran ration, while in the second experiment the conditions were reversed. The differences were so trifling that it may be said that for practical purposes both rations produced equally satisfactory results.

3. As a practical deduction, the writer would suggest that farmers who keep comparatively small herds, and who personally look after the feeding, may reduce the quantity of *purchased grain* to 3 or 4 pounds daily per head, and substitute home-grown corn in place of wheat bran. Five to 7 pounds of grain daily is the usual allowance for cows producing about 10 quarts of milk of average quality. This grain mixture may consist of 1½ pounds of cotton-seed meal, 2 pounds of flour middlings and 2½ to 3 pounds of corn or corn and cob meal daily; or 1½ pounds of cotton-seed meal, 2 pounds of oat middlings or rye feed and 2½ to 3 pounds of corn meal. Malt sprouts may be substituted for the wheat, oat or rye middlings. The several grains after being mixed should be distributed through the silage or cut hay with the aid of a fork. This method of feeding will enable the farmer to get along with a minimum *cash outlay* for grain (4½ cents daily), and at the same time he will be supplying a well-balanced ration, rich in elements of fertility. The method will be more particularly suited to farmers not having easy transportation facilities, and who sell their dairy products to the creamery.

4. Farmers and dairymen who cannot closely supervise the feeding, and who desire to feed more than 5 to 7 pounds of grain daily, will probably find it advisable to use one-third to one-half wheat bran in compounding the grain mixture. Distillers' grains and malt sprouts have also been shown to be quite satisfactory distributers of the heavy concentrates.[1]

---

[1] Bulletin No. 94 of this station.

REPORT OF THE BOTANIST.

G. E. STONE; ASSISTANT, N. F. MONAHAN.

The long period of dry weather during the past summer has rendered many plants free from certain types of fungous diseases. On the other hand, the dry conditions were favorable for the outbreak of other troubles. A considerable amount of rain fell, and a more or less prolonged period of cloudy and damp weather prevailed during the latter part of August and first of September, which brought on some severe cases of blight. This rainy and damp period, coming as it did after the severe drought, exerted a peculiar influence on the quality of fruit, and in some instances it was responsible for inducing a renewed activity of the reproductive organs of plants. It is well known that favorable conditions following a check often stimulate vital activity along the lines of reproduction, and it was not surprising to find some wild plants responding in this manner.

Downy Mildew of Tomato.

(*Phytophthora infestans*, DBy.)

The damp and rainy period following the prolonged dry season caused an unusual outbreak on tomato plants, namely, the downy mildew, which is the same as that giving rise to the late blight of potatoes. It is seldom that this mildew attacks tomatoes, in this State at least, to any extent; but this season the damage was quite severe and widely disseminated, especially injuring the younger vegetative portions of the plants.

Potato Rot.

(*Phytophthora infestans*, DBy.)

The fungus mentioned above was also responsible to a large extent for damage to potatoes, causing them to rot, especially those grown on moist land. During the early part of the season potatoes as a whole were remarkably free from blight, and not until the rainy and damp period came in September did they display any alarming troubles. In some instances quite a large percentage was destroyed by rot. The spraying of potatoes in this State has not met with that degree of success that it has in other New England States, one reason being that the early blight often occurs here quite disastrously, and obtains a foothold early in the season.

Spraying for this trouble should commence early in June, when the plants are about one-fourth grown, and continue until late in the season. Another factor underlying successful spraying is pressure; at least 50 pounds' pressure should be maintained by the pump, to secure the best results. Experiments at the college this year showed material gain in the quantity of potatoes secured from sprayed crops, as compared with those not sprayed.

Cucumber and Melon Blight.

The dry summer with its freedom from moisture proved favorable for cucumbers and melons, and these crops were not severely affected, at least previous to September, with either the downy mildew or anthracnose. During the past fall there has occurred considerable infection to greenhouse crops, especially those started early. For the last six or seven years the downy mildew (*Plasmopara Cubensis* (B. & C.) Humphrey) has occurred generally upon greenhouse cucumbers started early in the house, and occasionally the anthracnose (*Colletotrichum Lagenarium* (Pass.) Ell. & Hals.) appears in the fall, but we know of no instances where either of these blights has wintered in greenhouses. Both of these blights must therefore at present be considered as left over from summer. The anthracnose, however, usually makes its appearance in the spring on greenhouse plants, and the mildew about the 15th of August on either outdoor or greenhouse crops. Both of these blights can be readily controlled in the greenhouse by judicious attention to cultural methods. Neither of them will survive if attention is given to light, ventilation and especially moisture. When the foliage is kept dry these fungi are unable to get a start. In case syringing is necessary to keep the red spider down, it should be done in the morning in bright sunlight, at which time the plants will dry out readily. In case these blights have attained some headway, the pipes should be painted with sulphur and oil. Beneficial results have been reported by different growers who have tried this method.

Sun Scald.

The general interest manifested in shade trees in this State is quite apparent from the large number of specimens sent us each year, and the amount of correspondence touching upon various matters concerning them. The number of cases of sun scald to shade trees the past summer was unprecedented. This was particularly noticeable in rock maples and white pines, although this same trouble occurred with many trees and shrubs to some extent. The sun scald on rock maples was unusually abundant, and more severe than usual. Some trees which were under our observation had as much as ninety per cent. of their foliage as dry and crisp as casted leaves. Some maple trees possess the peculiarity of having their leaves badly scorched each year, where other trees of the same species located near them are entirely free from this trouble.

As a result of the prolonged drought and the excessive heat during mid-summer, many rock maples developed foliage of a peculiar bronze color. There was also much premature fall coloring and defoliation on many trees. The cause of so much sun scald during the past summer was drought and dry winds.

Where fine specimens of lawn or roadside trees exist, every effort should be made to maintain them in the best condition possible. A deep, rich, loamy soil, well supplied with organic matter, constitutes a good guarantee against sun scald.

Burning of Conifers and Evergreens.

The burning or drying up of leaves commonly seen on conifers and other evergreens in spring is the result of winter or spring injury. Trees affected in this manner show the burning generally on one side, which coincides with the direction of some prevailing wind or storm. This is a genuine scald, similar to that prevailing on other trees, and occurs at a time when the ground is frozen and drying winds prevail. This is usually brought about by a sudden rise of temperature in the early spring when the plants are in frozen ground, at which time transpiration is active. Under these conditions root absorption is limited, whether the soil is moist or dry, and burning results.

An arbor vitæ hedge, which has been under our observation for some years, located on high ground with a severe exposure, becomes burned more or less every year. Frequently the burning is on the southeast side and occasionally on the southwest, but more often on the northwest, which is the direction of the prevailing winds.

There is a considerable amount of burning to conifers and rhododendrons in this State, and not infrequently this is so bad that the specimens are ruined. Much of this injury occurred during the winter of 1904–05, on evergreens located on private estates and in nurseries. One nurseryman states, for example, that all his evergreens, which included various species of abies, buxus, chamæcyparis, juniperus, picea, pseudotsuga, taxus, thuya and tsuga, burned last winter, and other nurserymen have experienced trouble with retinosporas and varieties of thuya or arbor vitæ.

Our native conifers are seldom injured in this manner except when transplanted in some uncongenial place, or where the environment is more or less modified. Swamp cedar burns frequently when taken from the swamp and grown in ordinary soil, and the arbor vitæ, sparingly found as a native in this State, frequently burns when planted on high or more or less dry land with severe exposure. This holds good also for hemlocks, and to a certain extent for pines and junipers.

Winter-killing.

The disastrous effects of winter-killing are probably more discernible in the State at the present time than for many years; at least, we have no recollection of seeing so much damage done to so large a variety of trees and shrubs as has occurred in the last two or three years. The winter of 1903–04 was extremely severe on most of the native and exotic plants, including trees, shrubs and vines; and, while the winter of 1904–05 was not so severe in many ways, the past summer has done much to emphasize any trouble that was present to a slight degree before. The winter of 1902–03 was also a severe one, although the effects of killing during that period were largely above ground.

The symptoms of winter-killing are tolerably well marked in most instances, especially to the trained observer, and it is seldom that it need be confounded with anything else, neither is it always necessary to make extensive examinations of root systems to ascertain root killing. Furthermore, because a plant is native constitutes no evidence of its ability to withstand unusually severe conditions, since unusual seasonal peculiarities often render them less hardy. For example, the Labrador tea, which is a native of Labrador, has been known to winter-kill in this State, although the climatic conditions of this State are decidedly milder than those of Labrador. There are several classes of winter injury which may readily be distinguished, some of which are not unusual, and can be found every year. There is killing of that portion of the plant above ground as well as killing of the root systems, the latter being extremely common during the winter of 1903–04. Besides these types of injury mentioned above, there frequently occur frost cracks, twig killing, bud injuries, blisters to leaves, etc. The latter has occurred occasionally in leaves of apple trees in the spring when they were tender, and frequently results in almost complete defoliation of apple trees during August. This trouble has been studied by Sorauer in Germany, by Stewart in New York, and by Stone and Smith in this State.

Some of the conditions which underlie winter-killing are as follows: —

Severe cold, causing frost to penetrate to a great depth.

Sudden and severe cold following a prolonged warm spell in the fall, in which case the wood tissue is tender and immature.

Conditions which favor a soft growth and immaturity of wood. Various causes may be responsible for this, such as growth in a low, moist soil, too heavy manuring or fertilization, or absence of sufficient sunlight.

General low vitality, caused by insect pests and fungous diseases and lack of moisture in the soil.

Insufficient soil covering, such as lack of organic matter, light mulching and snow covering in winter.

Location in unusually windy and exposed places, etc.

Species with a limited maximum range for cold are especially susceptible. There are innumerable examples at hand which will furnish illustrations of the various causes of winter-killing. For example, low vitality is well illustrated by the large number of old apple trees which have died in the last two years. The old, neglected orchards were the worst sufferers from the effects of winter-killing, and many isolated trees, such as cherry trees that had received no care for some years, were badly affected.

In one instance a number of peach trees and various kinds of shrubbery, both native and exotic, were severely injured where located near an overflow from a cesspool, while similar shrubbery near by was not injured in the least. This injury was due to the more rapid and tender growth of those plants which received benefit from the cesspool overflow. Perfectly hardy native plants, being deprived of a normal amount of light or grown in too dry places, are winter-killed readily; and Japanese maples on high, dry ground with severe exposure are extremely subject to winter-killing.

By far the most noticeable effects of winter-killing have occurred above ground. This in some cases has resulted in local injuries to the trunk or in the loss of a few limbs, which has been responsible for completely ruining the symmetry of many valuable specimens, while in other instances many plants have died back to the ground. Some of the plants which have been affected in this way are as follows: Japanese maples, sycamore and Norway maples, apple, peach, plum, cherry, quince, grape vines, Japanese clematis, matrimony vine, roses, Forsythias, California privet, Amorpha fruticosa, Callicarpa purpurea and Americana, Ampelopsis tricuspidata, Deutzia scabra and gracilis, Diervilla florida-candida, Catalpa bungei, Exochorda grandiflora, Hibiscus syriacus, Magnolia tripetala, Lonicera japonica-halliana, Stephanandra flexuosa, Viburnum tomentosum, Tamarix tetrandra, Rhus semialata and Æsculus pavia.

Among the native plants may be mentioned the pine, ash, oak, white birch, alder, spice bush and holly. We observed large clumps of white birch and alders winter-killed above ground. The winter-killing of branches and twigs often occurs on young Japanese maples, especially where exposure is severe or when not given the best cultural conditions; and the young twigs of Norway and sycamore maples and horse-chestnuts have been quite susceptible to winter-killing of late. The killing of the buds and wood occurred in forsythias, peach and roses. Much of this winter-killing of branches, etc., is generally followed by an outbreak of Nectria cinnabarina and Schizophyllum.

As previously stated, the winter of 1903–04 was extremely severe in the amount of root killing which took place. The trees showing injury were the apple, pear, peach, quince, cherry, plum, white pine, red and rock maples, butternut, ash, oak and elm. Among shrubs, vines, etc., were the grape, raspberry and blackberry.

Many of the exotic ornamental plants suffered in the same way, such as, for example, the deutzias, California privet, etc.; in fact, many of the native and exotic species showed killing both above and below ground. The trees which have shown root killing the worst are apples, red maples, butternuts and pines. The effects of the winter-killing of roots manifest themselves in many ways. Sometimes the plant is killed outright, while in other instances only a slight injury is caused. Many maples, for example, were killed outright, while others lost only a certain per cent. of their roots, thus causing thin tops, and where this injury was not very extensive many of the thin-top trees recovered in one year.

In some instances the leaves at the top of the red maple remained in a half-developed condition throughout the summer. In such cases the leaves were rather pale in color, and they assumed a peculiar pendulent position on the branches. These trees have also for the past two years manifested a premature autumnal coloration, especially on those portions with poorly developed foliage, the result of a limited water supply caused by winter-killing of the roots.

Apple trees were affected to a large extent by root killing, and many hundreds of them have succumbed. In many cases these trees would have been saved if severe pruning had been practised at the time of the first appearance of this trouble, since severe pruning of the tops of the trees would have balanced the root and branch systems. Peach, plum and quince trees were affected in the same way, but the trouble was not nearly so general with these. The same holds true for blackberries, raspberries and grapes. One of the peculiarities displayed by many of these plants consisted in their leaving out and bearing fruit, then suddenly collapsing.

The white pine was the most extensively affected tree. These trees in some localities were so severely affected that many of them died during the spring following the winter of 1903–04. In some severe cases the trunks were frozen and badly injured, but in the greater majority of cases the tips of the new leaves became brown and died. The dry summer of 1905 was severely trying for these partially affected pines. Had a normal water supply been available, this injury would not have resulted. The specimens which we examined had a large percentage of the small, fibrous roots killed, but in no case observed had the large roots been injured. This pine injury extends throughout the whole State, but appears to be less common in the Connecticut valley than elsewhere.

One of the most distinctive features connected with the pine during the past summer was the burning of the tips of the leaves. In most cases the young, new leaves commenced to turn yellow at their ends, as if sun scorched, but usually grew worse; and in many instances all the needles turned yellow, subsequently died and dropped off. This might not occur on the whole tree, but on only one or more branches. Occasionally this trouble would occur before the young needles reached their normal length; and in such cases the needles would be short and the tree would present a stunted foliage, as we sometimes see on pines grown in very dry soil. Many were inclined to believe that some fungous disease was affecting the pines. Our examinations of the young needles in early summer showed no indications of fungi being present, and others have reported the same results. Subsequently, however, there appeared various species of fungi on the leaves, and in some cases on the branches, etc. This was merely a natural result following the weakened condition of the tree, caused by the affected root system.

Mrs. Flora W. Patterson of the Department of Agriculture in Washington, who had exceptional opportunities to examine the pine trouble as it occurred in New England and elsewhere during the summer, reports at least six different species of fungi upon the needles and branches. From examination of considerable material gathered in this State she has reported having found Phoma Harknessii, Sacc., Septoria parasitica, Hartig, Hendersonia foliicala, Berk. The Septoria was found in connection with the leaves that had their tips burned, and the Hendersonia was associated with a general yellowing or irregular spotting of the needles, while the Phoma was found with a quite different and by no means common trouble, causing no serious injury to the trees.

In conclusion, we would state that the trouble affecting the pine in this State was due primarily to the extreme winter-killing of the roots during the winter of 1903–04, together with the unusually severe drought occurring in the summer of 1905. The occurrence of so many different fungi on the pine, which especially predominated during the late summer and fall, was very largely a secondary result of the weakened condition of the tree caused by winter-killing.

Relation between Soil Aeration and Germination and Growth.

For some time our attention has been given to the relation existing between seed germination and plant development, and soil texture and aeration. This problem possesses a practical bearing, inasmuch as it underlies the question of soil selection for specific crops. It is not our purpose at present to go extensively into this subject, but only to touch upon one phase of it. It is well known to gardeners and others that aeration, or the presence of air in soils, plays quite an important role in the development of seedlings. This experiment was made to determine what effects forcing air through soil would have upon germination and growth. For this purpose we made use of loam placed in two boxes, 18 by 18 by 18 inches. In each box there was a round funnel, 4½ inches in diameter, buried under the soil 1½ inches from the surface. Both funnels were connected with block tin tubes leading outside of the box, one of which was attached for a period of six hours each day to a water blower, and the other remained unconnected. Lettuce seed, which is quite susceptible to aeration, was employed, and 1,500 seeds were placed in each box, and the necessary data pertaining to germination, etc., were noted.

Table showing Results of Aeration on Growth of Lettuce Seedlings. 1,500 Seeds in Each Box.

	Number of Plants obtained.	Weight of Seedlings (Grams).		Average Gain in Weight (Per Cent.).
		Total.	Average.	
Unaerated, ...	977	83	.0847	–
Aerated, ...	1,210	152	.1239	46.27

From the preceding table it will be noted that there was considerable more seed germinated in the aerated box than in the unaerated one, as noted by the number of plants obtained; and that the average weight of the seedlings in the aerated exceeded those in the unaerated by 46 per cent. The seeds in the aerated box showed decided acceleration in germination, there being a difference of at least thirty-six hours in favor of the aerated seed. This experiment lasted from October 5 to November 8, and the difference in the size of the plants became more marked each day. In the aerated box the plants were noticeably larger over the funnel, while in the unaerated box the plants were largest near the edges of the box, where the soil had shrunk away from the sides, which enabled the roots of the seedlings to have free access to air.

That oxygen plays an important part in the germination of lettuce seed is quite evident from many experiments we have made with this species. The mere fact of covering lettuce seed loosely or sifting fine loam on them results frequently in enormous differences in the germination. Such seeds as lettuce and white clover are particularly susceptible to aeration; and, according to our numerous experiments, these seeds germinate best in soils of loose texture.

Comparison of Sterilized Loam and Subsoil.

Some experiments were conducted two years ago by Mr. S. R. Parker, then a senior specialist in the agricultural department of the college, which necessitated using a sterilized soil. In all of Mr. Parker's cultures, which were made in a soil very poor in organic matter, there was an extremely poor and sickly growth of soy bean in those pots which had been sterilized, whereas the growth was good in pots which had not been steamed. The experiments were carried on in our greenhouse, and the results were so different from those occurring in sterilized loam that it was considered wise to repeat them.

A soil similar to this had previously been sterilized for the growth of tobacco seedlings, without producing similar disastrous effects upon the plants. In the single experiment given here we made use of a similar soil, namely, a yellow subsoil loam, containing little organic matter. Eight pots were selected, four of which contained loam and four subsoil. Of these, two each of the loam and subsoil pots were sterilized, and two each of the remaining pots were left unsterilized. The results follow.

Table showing Growth of Soy Bean in Sterilized and Unsterilized Loam and Subsoil.

	Total Number of Pots used.	Average Length (cm.) of Stems in —		Gain (+) or Loss (—) in Sterilized Soil (Per Cent.).
		Unsterilized Soil.	Sterilized Soil.	
Loam, ...	4	9.53	10.87	+14.05
Subsoil, ...	4	9.79	4.14	—57.70

The number of seeds germinated in unsterilized loam and soil was 30, that for the sterilized 34, showing a slight gain in favor of sterilization, which is unimportant, considering the small number of seeds used. There is also a gain in height of loam plants of 14 per cent. in favor of sterilization, while in the subsoil series there is a loss of 57 per cent. due to treatment. The subsoil pots also showed a poor, sickly development. This corresponded in every way with the results obtained by Mr. Parker in his experiments. This experiment shows, among other things, that extreme precaution is necessary in drawing deductions from experiments in which the soil is sterilized, especially where inoculation work is undertaken in connection with soil organisms.

Influence of Soil Sterilization on Seed Germination.

In a previous report [1] the results of a similar series of experiments were described, and this paper is a continuation of the earlier one. As in the preceding series, the seeds selected were in most cases from an old lot, which possessed a rather low germinating capacity. The object of these experiments was to ascertain the degree of acceleration in germination which would result from plant seed in steril-

[1] Fifteenth annual report of the Hatch Experiment Station, p. 41, 1903.

ized soil. Results of a similar nature have been observed by us a number of times in an incidental way when utilizing sterilized soils in our general experimental work in the greenhouse. The seeds were planted in boxes 18 by 12 by 3 inches, and previous to planting the soil in the sterilized boxes was heated by steam to a temperature of about 212° F. for one hour. The soil used constituted a good typical loam, characteristic of this region, and the sterilized and unsterilized soils were identical in every way except as to steaming. Other conditions, such as heat, light, degree of moisture, etc., were made the same as far as practicable. In Nos. 15 to 23, inclusive, 600 seeds were used in three separate experiments, where 100 seeds were sown in sterilized soil and 100 in unsterilized soil. In Nos. 25 to 34, inclusive, 800 seeds each were employed, there being two experiments. No. 39 is the result of only one experi-

Table showing the Germination of Seeds in Sterilized and Unsterilized Soil.

Laboratory Number.	Kind of Seed.	Total Number of Seeds tested.	Number Germinated in — Sterilized Soil.	Number Germinated in — Unsterilized Soil.	Per Cent. gained.
15, ...	Turnip, . .	600	159	54	35.00
16, ...	Radish, . .	600	148	101	15.66
17, ...	Onion, . .	600	148	94	18.00
18, ...	Red clover, .	600	236	203	11.00
19, ...	Lettuce, . .	600	289	267	7.33
20, ...	Musk melon, .	600	-	-	-
21, ...	Lettuce, . .	600	208	51	52.33
22, ...	Tomato, . .	600	79	63	5.33
23, ...	Crimson clover,	600	15	4	3.66
25, ...	Melilotus, . .	800	133	109	5.75
26, ...	Spinach, . .	800	378	246	33.00
27, ...	Peppergrass, .	800	233	106	31.75
29, ...	Japanese millet,	800	-	-	-
32, ...	White mustard,	800	242	65	44.25
33, ...	White carrot, .	800	-	-	-
34, ...	Winter vetch, .	800	30	8	5.50
39, ...	Soy bean, . .	1,000	365	175	38.00
Average, . .	. . . . .	-	-	-	21.89

ment, this being made in the greenhouse bench soil; 500 seeds were sown in unsterilized soil and 500 in sterilized soil.

The data given in the table show that there occurred a positive gain in germination of the seed sown in sterilized soil. Nos. 20, 29 and 33, however, were old seed, which had apparently lost their power of germinating, and the stimulating effect induced by soil sterilization evidently had no effect on them. There is no reason for believing that when seeds have once lost their germinating power, or, in other words, are dead, this process will revive them. The percentage gained in some instances is quite marked, while in others it is insignificant. The average obtained from this series is 21 per cent. On account of the low germinating capacity prevailing here in many instances, the percentage gained is only indicative, since it would be necessary to employ a larger number of seeds to obtain more accurate averages. It should be pointed out, however, that better results than those given in these experiments have been observed many times in connection with lettuce, cucumber, melon seed, etc., in the greenhouse, where seed was used on a much larger scale. The degree of acceleration in germination is also marked, a feature which has been frequently noticed by us before. The number of seeds germinated during the first few days of these experiments, including Nos. 15 to 34, inclusive, was 169 for the sterilized soil and 146 for the normal loam, or a gain of 14 per cent. in favor of the sterilized soil. In the former series of experiments, previously noted, we obtained 25 per cent. of acceleration at the end of four days. There undoubtedly exists a difference in seeds in their response to stimulation in sterilized soils. Tomatoes, for example, respond but little if any to this method of treatment. The cause of this variation in different species of seeds is not known. Experiments are now being made along different lines which may throw some light on this question. The benefit to be derived from sowing seed in sterilized soil, both from a physiological and pathological point of view, is important enough to warrant in many instances its practice.

Influence of Soil Decoctions on Seed Germination.

Some attempt has been made in the following experiments to ascertain the cause underlying the effects which sterilized soil has on seed germination. The question has often arisen, In what manner does soil sterilizing affect seed germination? Is the cause underlying this form of stimulation a mechanical one, or a chemical one? In all probability both mechanical and chemical factors play a role here. If, however, the stimulus is of a chemical nature (and such types of stimulation are common enough to seeds), we would expect some response to occur on the part of the seeds when treated with decoctions of sterilized soils. For special reasons we therefore selected two types of soils, one of which was a typical Amherst loam, fairly rich in organic matter and suitable for greenhouse culture; the other soil a yellow loam of the nature of an Amherst subsoil, deficient in nitrogen and containing only a slight amount of organic matter. Three sets of experiments were carried out with each soil. In each set there was a boiled loam and subsoil, a sterilized loam and subsoil, and a normal loam and subsoil. The boiling and sterilizing lasted fifteen minutes, the latter being mostly done in an autoclave, under fifteen pounds pressure and at a temperature of 250° F. In all cases 400 grams of soil were employed. The soils were placed in percolators, with 500 c.c. of distilled water, and allowed to stand for twelve hours and to percolate very slowly. Four hundred grams of normal loam and subsoil, that is, soil that is not treated, were percolated in the same manner as the others. In addition to the above tests, tap water cultures were employed as checks, and run parallel in every way to the others.

In some instances, however, distilled water was used, besides the tap water, but since no difference existed between them, the distilled water tests were discontinued. After a percolate had been obtained for the various soils, the seeds were soaked in them for six hours, and then placed in germinators of the Zurich type, or into germinators composed of flower pot saucers provided with filter paper. In one or two instances the soy bean was germinated in sawdust.

Table I. — *Showing the Influence of Soil Decoctions upon Germination of Seeds immersed for Six Hours in Decoctions made by percolating 500 c.c. of Water through 400 Grams of Soil; 800 Seeds used in Each Treatment, except with the Soy Bean, where only 700 were used, making a Total of 21,700 Seeds.*

Seed.	Percentage of Germination in —						
	Tap Water.	Normal Loam.	Normal Subsoil.	Boiled Loam.	Boiled Subsoil.	Sterilized Loam.	Sterilized Subsoil.
Soy bean, . .	28.3	25.5	33.0	33.9	34.9	18.6	32.6
Buckwheat, . .	59.8	72.0	70.7	69.5	70.8	53.5	73.1
Radish, . . .	52.7	51.7	53.1	51.8	56.7	48.5	52.3
Lettuce, . . .	70.2	82.3	71.8	80.7	77.6	71.6	61.8
Average, . .	52.7	57.8	57.1	58.9	60.0	48.0	54.9
Total average,	52.7	57.4		59.4		51.5	

The preceding table shows the results obtained from experiments in which 21,700 seeds were employed. Since a large number of seeds were used in these experiments, quite accurate averages were obtained, and the factors due to variation are eliminated to a large extent. There is apparently a slight gain due to treatment shown in these experiments. The best average results were given by the boiled subsoil and loam, followed by the normal, while the sterilized loam is below the tap water seeds. By noting carefully the results obtained in these experiments, together with the nature and color of the decoctions, we surmised that the decoctions were too strong for the best results, consequently they were diluted with water to one-half strength in the next experiment.

TABLE II. — *Showing the Influence of Soil Decoctions upon Germination of Seeds immersed for Six Hours in Decoctions made by percolating 500 c.c. of Water through 400 Grams of Soil, diluted to Half Strength; 600 Seeds used in Each Treatment, making a Total of 16,800 Seeds.*

SEED.	PERCENTAGE OF GERMINATION IN —						
	Tap Water.	Normal Loam.	Normal Subsoil.	Boiled Loam.	Boiled Subsoil.	Sterilized Loam.	Sterilized Subsoil.
Soy bean,	50.0	50.2	51.0	55.5	53.5	55.2	51.7
Buckwheat,	77.2	70.5	81.2	82.5	83.5	72.5	73.0
Radish,	48.0	53.2	48.0	59.7	53.0	60.5	58.5
Lettuce,	82.2	83.7	87.2	78.0	73.7	74.0	80.8
Average,	64.3	64.4	66.8	68.9	65.9	65.5	66.0
Total average,	64.3	65.6		67.4		65.7	

These experiments are similar to the previous ones, except that half-strength decoctions were used in all cases. The results obtained from these three experiments are remarkably uniform in character, the tap water giving practically the same results as the decoctions.

TABLE III. — *Showing the Influence of Soil Decoctions upon Germination of Seeds immersed for Six Hours in Decoctions made by percolating 500 c.c. of Water through 400 Grams of Soil, diluted to One-fourth Strength; 600 Seeds used with Radish and Buckwheat, 400 Seeds with Lettuce and Soy Bean, making a Total of 14,000 Seeds.*

SEED.	PERCENTAGE OF GERMINATION IN —						
	Tap Water.	Normal Loam.	Normal Subsoil.	Boiled Loam.	Boiled Subsoil.	Sterilized Loam.	Sterilized Subsoil.
Soy bean,	84.0	74.5	89.5	73.0	83.5	77.5	84.0
Buckwheat,	66.5	91.7	85.0	93.7	91.7	82.7	83.7
Radish,	65.5	64.5	62.5	46.5	50.0	55.5	56.5
Lettuce,	74.5	72.7	72.7	63.7	70.7	65.2	69.5
Average,	72.6	75.8	77.4	69.2	73.9	70.2	73.4
Total average,	72.6	76.6		71.5		71.8	

In the experiment with the one-fourth strength decoctions, 14,000 seeds were employed, representing three experiments. There is a slight increase shown in this series, due to treatment, which is the most marked in the normal loam and subsoil.

TABLE IV. — *Showing the Influence of Soil Decoctions upon Germination of Seeds immersed for Six Hours in Decoctions made by percolating 500 c.c. of Water through 400 Grams of Soil, diluted to One-eighth Strength; 200 Seeds used in Each Treatment, making a Total of 5,600 Seeds.*

SEED.	PERCENTAGE OF GERMINATION IN —						
	Tap Water.	Normal Loam.	Normal Subsoil.	Boiled Loam.	Boiled Subsoil.	Sterilized Loam.	Sterilized Subsoil.
Soy bean, . .	75.5	75.0	75.5	85.5	85.0	87.0	80.5
Buckwheat, . .	66.5	82.0	83.0	84.5	81.5	78.5	83.5
Radish, . . .	55.0	70.0	69.0	77.5	81.5	78.5	72.0
Lettuce, . . .	70.0	68.5	74.5	98.9	73.0	77.0	79.5
Average, . .	66.7	73.8	75.5	86.6	80.2	80.2	78.8
Total average,	66.7	74.6		83.4		79.4	

The experiment with one-eighth strength decoction shows a decided gain throughout in the treated seeds, the most marked being given by the boiled and sterilized loams and subsoil decoctions. No further dilutions were tried, but from a careful study of the results of these experiments we are inclined to the belief that if more dilute solutions were used an increased gain would occur, especially in the sterilized series, since the most highly colored decoctions were obtained from the sterilized soils and the next highest color from the boiled soils. It appears to us that the sterilized decoctions were too strong, even when diluted to one-eighth strength. Some variation in the strength of the decoctions is likely to occur as a result of different percolators, and the failure of the one-fourth and one-half strength to show more of an acceleration may be attributed to this cause.

The following table gives the number of seeds that germinated in the first twenty-four hours in the preceding experiments, including tables I., II., III. and IV., from which the degrees of acceleration and retardation due to treatment can be obtained.

TABLE V. — *Showing the Degree of Retardation and Acceleration in Germination of Seeds soaked for Six Hours in Decoctions of Different Strengths made by diluting 500 c.c. of Water which had percolated through 400 Grams of Soil treated as below.*

	Number of Seeds per Treatment.	PER CENT. GERMINATED IN TWENTY-FOURS HOURS IN —						
		Tap Water.	Normal Loam.	Normal Subsoil.	Boiled Loam.	Boiled Subsoil.	Sterilized Loam.	Sterilized Subsoil.
Soy Bean.								
Full strength, . .	600	27.7	27.5	30.5	33.1	29.5	8.3	27.5
Half strength, . .	200	22.0	20.0	17.0	21.0	23.0	23.0	23.5
Buckwheat.								
Full strength, . .	600	56.0	70.1	73.6	63.1	66.6	33.8	70.8
Half strength, . .	400	55.0	44.2	57.5	57.2	31.7	36.7	46.2
Quarter strength, .	400	43.7	59.5	50.2	57.2	59.0	52.7	64.5
Eighth strength, .	200	58.5	70.0	66.0	78.0	74.5	62.0	62.5
Radish.								
Full strength, . .	800	36.7	27.0	29.8	30.5	37.5	16.6	32.0
Half strength, . .	400	28.0	37.5	30.2	41.7	37.5	43.0	32.2
Quarter strength, .	400	45.0	43.5	39.0	17.5	24.0	37.0	37.0
Eighth strength, .	200	32.5	64.5	61.5	68.0	73.0	69.5	61.0
Lettuce.								
Full strength, . .	800	37.5	35.8	39.3	34.5	41.5	37.3	35.1
Half strength, . .	400	59.0	72.5	63.2	74.0	46.0	50.2	70.7
Quarter strength, .	400	67.0	52.0	55.7	44.5	51.5	53.5	56.5
Eighth strength, .	200	51.0	55.0	55.0	83.0	52.0	72.0	64.5
Average, . .	-	41.8	45.3	44.7	47.3	43.7	39.1	45.9
Average normal and total treated.	-	41.8	45.0		45.5		42.5	
		41.8	44.3					

This table gives the results of germination during the first twenty-four hours of 42,000 seeds, and the degree of acceleration obtained corresponds in a general way with the total number germinated as given in the preceding tables; or, in other words, the relationship between acceleration and the total number of seeds germinated is similar. Comparing the average number of seeds germinated during the first twenty-four hours by the various treatments with tap water, there are no important differences shown. On the whole, however, there is a gain or acceleration due to treatment, the maximum acceleration being shown by the boiled loam.

A comparison of the different strengths of solutions shows that the one-eighth dilution produced the best results of any of the treatments, that for boiled loam being the highest. This series of experiments shows that decoctions of soils variously treated induce acceleration in seed germination, and that a larger number of seeds germinated in decoctions than in tap water. This increase is quite marked in dilute decoctions (one-eighth strength), and would probably be increased to some extent if the dilution should be carried still further. In these experiments we have a chemical explanation for the cause underlying acceleration and increased germinating capacity in sterilized soils. Undoubtedly driving out the gases and the subsequent absorption and renewal of fresh oxygen in sterilizing practices acts beneficially to soil and induces the seeds to germinate more quickly, as is shown by the aerating experiments previously reported. By the process of aeration, or by soaking seeds in dilute decoctions, many seeds germinate that otherwise would not; but there is no ground for belief that any of these stimulating processes actually revive or rejuvenate worthless seeds to a greater extent than would result from the most favorable conditions for germination.

Sterilized subsoil, or that lacking in humus, has the same effect on germination as sterilized loam rich in organic matter; but it inhibits growth to a very large extent, thereby differing in this respect. It would appear, therefore, that a considerable amount of humus is necessary in soils, in order that they may be materially benefited by sterilization.

The reason that bacteria multiply more and plants grow much more luxuriantly in sterilized soils is undoubtedly due to the fact that a larger amount of available material for plant development is present. Why subsoils and those poor in organic matter give rise to a greatly inhibited growth is not so clear at present, and we are not prepared to offer any explanation of this phenomenon.

Seed Selection.

It is a well-known fact that heavy, well-developed seeds produce more vigorous and more productive plants than lighter seeds of the same variety. This is altogether a reasonable statement, because the heavy, well-filled seed has the more perfect embryo, and also has the larger supply of plant food on which to support the seedling until the plant is capable of getting its nourishment from the air and soil.

With such crops as wheat, rye and the grasses, the selection of seed is not of so very great importance, because usually an overabundance of seeds is planted, and sufficient seeds develop so that in the natural struggle for existence in their overcrowded state the weaker and less vigorous plants are crowded out and only the more vigorous and healthy plants reach maturity; and this number which reaches maturity represents the maximum number of plants that can be developed under existing conditions, so that nothing in the crop is lost by this crowding out of the weaker plants. On the other hand, with greenhouse, market gardening and general field or what is known as hoed crops, the conditions are entirely different. In this case each plant has its full share of light, heat and space, and a poor, weakly plant is just so much loss, not only because it occupies a space that ought to produce a well-developed plant, but also because a number of undersized, weakly plants in a crop detracts from the market value of the crop as a whole, and also because weak plants are more subject to disease, and act as a breeding-place for diseases that may infect the whole crop; therefore, the careful selection of seed becomes an important factor in growing plants. In the case of large seeds, such as corn, this selection is comparatively an easy matter. An ear of corn of the desired type, having kernels of a desirable size and shape and of full development, may be picked out, and by discarding the poor, undeveloped seeds at either end the rest of the seeds may be utilized for planting. Here knowledge of the type of seed and judgment only may be relied upon. Beans, peas, etc., may be selected in much the same way, with reasonable assurance that the best results will be obtained. In the case of such seeds as lettuce, turnip, cabbage, tobacco and other small seeds this method of separation is not practicable, and other methods have to be resorted to.

From early times the separation of seeds by means of water has been practised to a considerable extent. In this case the seed is placed in a quantity of water, well shaken and let stand a few minutes, then the seeds which do not sink are removed, and only those that have sunk used for planting.

The results of some of our experiments with this method of separation are given in the tables following.

TABLE I. — *Showing the Results of Germination with Onion and Lettuce Seed separated by the Water Method; 400 Seeds used in Each, or a Total of 1,600.*

Seed.	Per Cent. germinated of —		Per Cent. Increase of Germination of Heavy over Light.
	Light.	Heavy.	
Onion, ...	38.0	85.0	142.5
Onion, ...	50.0	58.5	17.0
Onion, ...	44.0	88.0	100.0
Lettuce, ...	68.0	90.0	32.3

TABLE II. — *Showing the Results of Seed Germination and Growth of Onion Seedlings separated by Water; 200 Seeds in Each Lot, or a Total of 400 used.*

Onion.	Per Cent. of Germination.	Number of Plants.	Weight of Plants (Grams).		Average Per Cent. gained of Heavy over Light.
			Total.	Average.	
Heavy (sank), ...	42.5	85	18.1	.213	37.42
Light (floated), ...	19.5	38	5.9	.155	–

This method, however, is not entirely satisfactory, because many of the heavier seeds are buoyed up by air bubbles and therefore thrown away, and in our work we have noticed that a few of the undersized seeds also go to the bottom.

Many investigators[1] have carried this process still farther, and separated their seeds by what is known as the specific gravity method. In this case solutions of salt (sodium chloride), ammonium nitrate, sodium nitrate, potassium nitrate and calcium chloride have been used. For this purpose solutions of different specific gravities have been made, in which the seeds were placed, first in that solution with the highest specific gravity. The seeds which floated in this solution were skimmed off and placed in that of the next highest specific gravity, and so on. It has been found that by this method seeds of the same variety, of a uniform, sound condition, differ in specific gravities only within a very narrow range. This, however, does not seem to be a very practical plan, as it involves the making of solutions of tested specific gravity and quite a little mechanical manipulation. Another method, known as the specific gravity sampling method, is perhaps of less value, as in this case one lot of seed is compared with others in bulk, without separating the poor and undeveloped seeds. It amounts simply to the choosing of the best lot from several samples of seeds.

The separation of seeds by sieves would seem to be the easiest and most practical way, and this method with us has given very good results. We used a series of four sieves, having round perforations of 2 mm., 1.5 mm., 1 mm., and .05 mm. respectively. Ten grams of seed were weighed out and run through this series of sieves, with the following results: —

TABLE III. — *Showing the Results of sifting Seeds, in which 10 Grams were employed.*

Number of Sieve.	Size of Seed.	Weight in 10 Grams of Seed (Grams).	Per Cent.
No. 1, ...	2.0–1.5 mm.	1.015	10.15
No. 2, ...	1.5–1.0 mm.	6.689	66.88
No. 3, ...	1.0– .5 mm.	1.800	18.00
No. 4, ...	.5– .0 mm.	0.491	4.91

[1] Among whom may be noted V. A. Clarke, New York (Geneva) Experiment Station, Bulletin No. 256.

Five hundred seeds were then counted out from each of these four grades or sizes of seeds, with the exception of No. 4 (.5–.0 mm.), which was composed entirely of chaff, dirt, etc. These were sown in flats and allowed to grow for four weeks, when the seedlings were taken up, counted and weighed, with the following results: —

TABLE IV. — *Showing the Results of Germination and Growth of Seedlings from Three Experiments with Sifted Lettuce Seed; 1,500 Seeds used in Each Experiment, making a Total of 4,500 Seeds employed.*

SIZE OF SEED.	Per Cent. germinated.	Number of Seedlings.	WEIGHT OF SEEDLINGS (GRAMS).		Average Per Cent. gained in Weight of Large over Small Seedlings.
			Total.	Average.	
2.0–1.5 mm., . . .	56.7	672	347.5	.518	98.42
1.5–1.0 mm., . . .	53.5	642	293.7	.457	75.09
1.0– .5 mm., . . .	40.4	485	126.3	.261	–

From this table it will be seen that of the large 16.3 per cent. and of the medium 13.1 per cent. more seeds germinated than of the small seeds, and that the four-weeks-old seedlings from the large seed averaged 98.42 per cent. and those from the medium seed 75.09 per cent. heavier than those from the small seed. It will also be noticed that the differences in the per cent. of germination and the weight of seedlings from the large and medium seeds were not very great; but the difference between the germination, and especially in the weight of seedlings of the larger and small seeds, is very marked.

We are of the opinion that it would pay a grower to separate his lettuce seed with a sieve having a mesh of one millimeter in diameter (1/25 inches), and to use only such seed as did not pass through a sieve of this size. From these plants he could make a further selection, as is customary at the time of transplanting. This would result in saving considerable ground space which is valuable, and not only would a more vigorous and uniform setting of lettuce be obtained, but the treatment would also eliminate many weak and undesirable plants, which are more likely to be susceptible to disease. In other words, much of the selection would be done more cheaply and easily by sifting the seed than as it is done at the present time, by selection in the seed bed. A sieve of the size mentioned can easily be made by purchasing from almost any tin shop a piece of colander tin of 1 millimeter mesh, which can very readily be soldered to a suitable rim, or even fastened to a tomato can which has had the bottom removed.

Our experiments in sifting seed have been confined, however, for the most part to lettuce seed; and, while these seeds can be separated in this way very easily, much more difficulty would be experienced in separating some other types of seed, such as turnip or tobacco; and another objection to this method is that the size and weight of seeds do not necessarily correspond, that is to say, a large seed may not necessarily be a heavy one. When seeds are separated by sifting, while the largest size contains practically all of the heaviest seeds and the lighter seed is practically all in the small sizes, there will be a few light seeds in the larger size and a few heavy seeds in the smaller sizes, so that this method by no means gives an absolute division of the seeds by weight, which is the ideal method of seed selection.

Mr. A. D. Shamel of the Connecticut (New Haven) Experiment Station uses a very satisfactory method for the separation of tobacco seed, which we can do no better than describe in his own words: —

This seed separator consists of a glass tube 1 inch in diameter and 5 feet long, and a glass receptacle for holding the seeds, having the diameter of the long glass tube, and so arranged with a finely woven wire screen in the bottom as to hold the seeds in the receptacle, and at the same time freely admit a current of air directly into the seed. The top of this receptacle is fitted with a coupling into which the long glass tube can be set and held in place. The current of air is developed by a common foot bellows and regulated with a valve. The seed to be separated is poured into the receptacle, usually about 1 to 2 ounces at a time, the glass tube set in place and a current of air pumped into the seed. The lightest seed and chaff are first blown out of the tube, and next the small seed. Small seed of the same character as the larger seed have proportionally more surface than the larger, consequently the small as well as the light seed is removed by this machine.

This seems to be the most satisfactory way of separating seed that has yet been devised, and no doubt some simple, inexpensive instrument modelled from this device will soon be available for every farmer and seed grower. The particular advantages of this method seem to be that this device is adaptable to all kinds of small seeds, the only adjustment needed being in the regulation of the amount or force of air sent through, and that by this method the seed is separated according to weight.

In conclusion, we believe it desirable with many kinds of garden seeds to separate the seed and discard all except the large, well-developed, mature and heavy seed, because: —

First. — About 33 per cent. of seeds as placed on the market consist of dirt, chaff, and small, undesirable seeds.

Second. — Small or light seeds do not germinate well, and their seeds produce only poor, small, undesirable plants, which prove inferior in every way.

Third. — Heavy seeds produce healthy, large, well-developed plants, that will give maximum crops.

Fourth. — Seed selection or separation is an inexpensive process that gives good results.

Asparagus Rust.

The past summer in most parts of Massachusetts has been an extremely dry one, and especially favorable, as was early anticipated, to an early and severe attack of asparagus rust. The confinement of the rust, or at least its injurious stage, to special localities has been the same this season as in other years; in other words, it has been confined to soils especially coarse, and easily affected by drought.

Since 1896 there have been about three severe outbreaks of the rust in this State, such outbreaks being identified with a dry summer, or at least with seasons where there have existed long periods between rainfalls. The fall or teleuto stage, however, has been present every year since

1896, and it has always been widely distributed. Any bed which has become once infected with this stage remains so, but fortunately the damage occurring from teleutospore infection is insignificant, and in the majority of cases not discernible. Asparagus rust has now become quite well distributed over the United States, but its virulence does not show itself in the same degree for every locality, and the problem of control is by no means everywhere the same, since factors enter into the problem which do not possess the same significance for all locations. In this State rust is most intimately associated with lack of vigor, and more particularly with those factors which underlie vigor, such as supply of water and judicious fertilizing. For this reason the most efficient remedies are based upon those practices the application of which induce vigor. There are a number of remedies which can be applied, some of which have given excellent results. Thorough cultivation and fertilization in more than one instance have given results which have proved superior to any other method of treatment. We have observed that the results from weekly cultivation combined with judicious fertilization have proved very satisfactory. Irrigation has also proved very effectual during dry seasons; but there is possibly a tendency for asparagus to become too succulent with repeated irrigation, which might possibly render the plant more susceptible to infection.

We also believe that an efficient practice pertaining to rust infection consists of burning the old brush in the fall, since a large number of teleutospores are destroyed, which, if left remaining in the ground over winter, would germinate freely in the spring and constitute a dangerous source of infection. We have repeatedly attempted to germinate teleutospores in the early winter, but failed. They will germinate freely in March, however. Moreover, the roots from infested plants, when transplanted in the greenhouse in the fall and left there for a year and allowed to develop tops, have never shown any tendency to rust. This would seem to indicate that not only is a resting period essential, as is usually the case for spores, but freezing also is essential. We are of the opinion that most beds are infected in this State by teleutospores during the spring and summer, and that the mycelium works up through the stem; and if the conditions for the plant are unfavorable, pustules bearing uredospores will break out in July or August, whereas, if the conditions for the plant are favorable, pustules bearing teleutospores will make their appearance during September or later.

In case uredospores break out in the plant during July and August, other beds in the vicinity, if in suitable condition, will invariably become infected. If, however, the crop is in a vigorous condition, even if located close by, it will resist the outbreak of the rust. This, indeed, has occurred many times in beds side by side, although of different age and vigor, and in the case of those beds more or less remote it may be stated that there are hundreds which have never had any uredo outbreak.

We observed a young bed of asparagus the past summer, about two years old, which had never been cut, and which had a teleutospore outbreak early in July. This bed suffered much from drought, and was not in an especially vigorous condition. It was, however, located on soil of fine texture, intermingled with coarse pebbles. There was little inclination for the plants of this bed to grow worse, notwithstanding the fact that drought prevailed, and it remained in practically the same condition all summer. On dry soil this never occurs, since it is the uredo stage that makes its appearance in these soils in July and August; and plants infected with this stage turn brown in a short time after they become infected. Moreover, the teleutospore outbreak occurring in summer is a perfectly harmless factor, as far as immediate infecting of the bed is concerned. Our studies of the rust problem have shown that there is an intimate connection existing between the texture and water contents of soils and uredospore outbreaks, and a series of water determinations of different soils during the season would probably bring out some interesting facts.

Spraying with Bordeaux mixture has not proved satisfactory in this State as a means of controlling the rust, and little or no use is now made of it for this purpose.

Some reports have been made concerning the use of the sulphur wash spray recommended by Prof. R. E. Smith, formerly of this station. This mixture, which consists of sulphur, soap, potash and water, possesses remarkable sticking qualities, and it is undoubtedly the most efficient mixture recommended for spraying for asparagus rust.

An Application of the Copper Sulfate Treatment.

Early in the summer the college pond became so overrun with Algæ as to be unsightly, and the smell of this decaying vegetable matter was so unpleasant that it became necessary to treat it.

Microscopic examinations of the water showed that it contained a considerable amount of short suspended filaments, of a slightly whitish or greenish color, which proved to be *Anabæna flos-aquæ*, a form of Algæ found frequently in public water supplies, and which gives rise to considerable trouble. The water content of the pond was roughly determined, and then treated with 1 part of copper sulfate to 4,000,000 parts of water. The required amount of copper sulfate was placed in a loosely woven sack and hung over the stern of a canoe, which was paddled around the pond in concentric circles for about one-half an hour, when all the copper sulfate was dissolved. This is the method recommended by Drs. Moore and Kellerman in their work on treating reservoirs with copper sulfate. A careful examination of samples taken twenty-four hours after treatment showed a slight decrease in *Anabæna*, and in two or three days it had practically disappeared.

Spirogyra, which was present along the shores near the inlet at the time of treatment, was not affected, and subsequently a number of large clumps were found in a flourishing condition in different parts of the pond, and many forms of Algæ, such as *Desmids* and *Diatams*, appeared not to be in the least affected by the treatment. Neither did the animal life seem to be affected in any way by the treatment, as no ill effects could be noted on the fish, frogs, tadpoles or other fauna inhabiting the water.

Of the *Protozoa*, the *Ceratium* was very numerous both before and after treatment, and was in no wise affected by the copper. *Daphna*, a form of Crustacea, was also plentiful, and experienced no ill effects from the copper treatment.

From day to day the bacterial contents of the water were determined, with the results shown in the following table: —

Copper Sulfate Test on Massachusetts Agricultural College Pond Water.

Date of taking Sample.	Number of Bacteria per Cubic Centimeter of Water.
1905.	
June 17 (one hour after treatment),	6,224
June 19,	3,463
June 20,	219
June 21,	336
June 22,	1,583
June 23,	1,187
June 24,	538
June 25,	1,144
June 26,	1,399
June 27,	1,144
June 28,	616
June 29,	763
June 30,	1,145
July 1,	1,078
July 3,	1,078
Sept. 16,	990
Sept. 17,	1,017
Sept. 18,	990
Sept. 19,	636

From this table it will be seen that the bacteria decreased very rapidly for the first few days after treatment, and, while they slowly increased again, they never reached their former numbers. The results obtained on June 24, 28 and 29 may be attributed to an unusually clear or settled state of the water on those days, while when the other samples were taken the water was considerably agitated, either from the effects of rain or wind.

A second treatment was contemplated in September for the purpose of studying the effects of copper sulfate on bacteria; but as the bacteria showed no appreciable increase at this time, we thought it not worth while to inaugurate another experiment. Samples of water taken one hour and twenty-four hours after treatment were tested for copper by the foods and feeding department of the station; and, while possible traces of the copper were found, they were so small and uncertain that no copper could be reported. In these tests the ferrocyanide method was employed, which in numerous other cases has failed to give reliable results where such small quantities of copper are present.

At the time these chemical tests were being made for copper there came to our notice a test described and recommended by Dr. Ewerts,[1] which claimed to detect one part of copper in 30,000,000 parts of water. This test is based on the inhibiting action of copper to diastatic action. This method was given a trial in the foods and feeding chemical laboratory, and found to be unsatisfactory. Quite likely, however, a detailed study of this latter method, together with some practice, will prove it to be of some value.

The result of this single experiment with copper sulfate in treating the college reservoir is not sufficient in itself to allow deductions of great value. They corroborate, however, the experiments made by Messrs. Moore and Kellerman on the Belchertown reservoir, and those made elsewhere, in showing that *Anabæna* is extremely susceptible to copper, and can readily be killed by this method of treatment. Moreover, the general clearing up and rapid disappearance of odor from the water two or three days after treatment, together with the falling off of bacteria, was quite noticeable. It should be stated, however, that there was a fall of about 20° in the temperature on the third day after treatment, which would have a tendency to affect *Anabæna;* and about one and one-half inches of rain fell between the 19th and 24th of June.

[1] Ztschr. Pflanzenkrank, Bd. XIV., 3 Heft., p. 133.

A Comparison of the Numbers of Bacteria in Sterilized and Unsterilized Soils.

BY A. VINCENT OSMUN.

There has been repeated inquiry as to the effect sterilization of soil has upon its bacterial flora. In the absence of any reliable experiments touching upon this question, it has frequently been assumed that by soil sterilization the bacteria, and especially the beneficial ones, are destroyed, hence injuring the soil. In regard to this question, it may be stated that little is known about either the so-called beneficial or injurious bacteria of greenhouse soils; and, in consequence of a paucity of knowledge upon this phase of the subject, positive statements are out of place. From what is already known about the effects of soil sterilization upon plant growth and the changes which such soil undergoes, it might be assumed upon *a priori* grounds that soil bacteria would be found to exist more abundantly in sterilized soil than in unsterilized soil. Moreover, it must be borne in mind that absolute sterilization is never accomplished, but something more closely approaching pasteurization takes place. All bacteria are by no means killed, as has been shown by various tests made at this station.[1] Subjecting soils to steam heat has a marked stimulating effect on the growth of plants. Observations at this station and experience of growers have shown this to be true. Just why this treatment of soil should stimulate the growth of plants is not known. Sorauer[2] suggests that steam heat makes the humus compounds more available to plants. It is not unlikely that steam flowing through a soil also improves its mechanical condition.

The stimulating effect of soil sterilization on plant growth suggested a similar effect on the bacterical content of soil so treated; and in order to obtain more evidence regarding this point this experiment was planned: —

Two boxes about 20 inches square and 9 inches deep and of equal weights were filled to the depth of about 5 inches

---

[1] Hatch Experiment Station, Massachusetts Report, 1902, pp. 77, 78.

[2] Sorauer, The Physiology of Plants, pp. 45, 46.

with equal amounts by weight of soil from the supply bin of the station greenhouse. Before filling the boxes a quantity of soil from the bin was thoroughly mixed, and the boxes filled from that, so that the soils in the two boxes were as nearly alike as possible. The soil in one box was treated for half an hour with flowing steam applied through perforated tubes buried beneath the surface; the soil in the other box was untreated. One week after sterilization a sample was taken from each box for the determination of the numbers of bacteria in the soil, after which the boxes were placed on a platform scale and brought to equal weights with water. Water was similarly applied every day during the experiment, and the soil always contained from 17 to 20 per cent. moisture. Samples for the determination of the quantitative bacterial content of these soils were taken at intervals of about two weeks. The soil was frequently stirred, and at the times of sampling the entire contents of each box were thoroughly mixed and pulverized.

The results of this experiment are tabulated in the accompanying table: —

Showing the Relative Number of Bacteria in Sterilized and Unsterilized Loam.

Date of taking Sample.	Number of Bacteria per Gram of Dry Soil.	
	Sterilized.	Unsterilized.
1905.		
April 3,	6,742,000	56,273,000
April 18,	64,596,000	39,080,000
May 1,	66,089,000	31,372,000
May 16,	29,963,000	8,029,000
June 1,	26,666,000	14,634,000

The figures in this table show that steam flowing through soil for half an hour not only does not kill all the bacteria in that soil, but that it seems to act as a stimulus, causing rapid mutiplication of numbers. Practically all vegetative forms would be killed, but most spores would be uninjured, and, given favorable conditions after treating, would germinate. One week after sterilization the treated soil contained nearly 7,000,000 bacteria per gram. This number is probably considerably in excess of the number in the same soil immediately after sterilization, but it indicates that treating soil with live steam at about 210° F. for half an hour does not kill all the bacteria in that soil. The untreated soil contained a good number of bacteria at the beginning, — about 56,000,000.

During the four weeks immediately after the first samples were taken there was a phenomenal increase in the number of bacteria in the sterilized soil. From 7,000,000 per gram at the beginning the number had advanced to nearly 65,-000,000 at the end of two weeks, and after four weeks to over 66,000,000. On the other hand, the number in the untreated soil showed a steady decrease, for which no cause is at present apparent.

After six weeks the numbers of bacteria in both sterilized and unsterilized soils had dropped way below the numbers found at the end of four weeks. During the next two weeks the sterilized soil continued to drop off, though not to any great extent, while the unsterilized soil advanced.

At this point it became necessary to discontinue the taking of samples because of the press of other work.

We are unable to account for the decrease in numbers of bacteria in either sterilized or unsterilized soil. A similar decrease in numbers of bacteria has been noted in other experiments in the greenhouse in which unsterilized soil was used. The temporary increase in numbers in the sterilized soil may be attributed to the stimulus given by the steam heat; and it appears also that sterilization had a tendency to overcome, for a time at least, the antagonistic agency or agencies which caused the decrease in the unsterilized soil.

More extended experiments and observations are necessary before definite conclusions can be reached regarding the effect of so-called sterilization on the bacterial contents of soils; but from the results obtained in this experiment and from tests of other soils, both sterilized and unsterilized, we may conclude that steam treatment of soils greatly stimulates bacterial development in them, and that if certain as yet unknown adverse conditions can be removed, the high numbers may be retained indefinitely.

REPORT OF THE ENTOMOLOGISTS.

C. H. FERNALD, H. T. FERNALD.

The year 1905 has been marked by a great abundance of insects of many kinds, while the two years preceding were equally marked by their scarcity. To this fact is probably due the large increase in the amount of correspondence the present year, nearly two thousand letters having been sent out, besides an unrecorded amount of printed matter, in answer to questions received.

Investigations as to the number of broods and times of appearance of the codling moth and oyster-shell scale have been continued during the season, and should be repeated for several years to come, that reliable date averages may be obtained, and thus the best times for the treatment of these insects be ascertained.

Several private insecticides have been more or less tested and the results noted, statements of these having been supplied in each case to the persons sending the materials. While some of these substances were shown to have a certain value for the destruction of insects, it was noticeable that they were no more effective than well-known insecticides costing less, or that they were injurious to the foliage of the plants they were tested on. In fact, none of the materials tested at this station during the year can be considered as adding anything of value to our present list of standard insecticides, though it has taken considerable time from other work to establish these negative results.

The collections of the division have, as usual, been given the needed care and have been added quite considerably to during the year, while additional facts as to the distribution of insect pests in Massachusetts and their habits have been gathered and recorded. The card catalogue has been kept abreast of the new publications and improved in many ways, and requests for the information it contains are frequently received from other stations and from individuals.

Some study has been given to the carnation twitter, and the identity of the insect causing this trouble has been ascertained with considerable though not absolute certainty. Further investigations on this subject will be made during the coming year if material to study can be obtained.

Special researches have also been continued on the Asilidæ or robber flies; the Pyralidæ, a group including many very injurious insects; the Bombinæ or bumble bees and their habits; and on the Sphecidæ or digger wasps, these studies being of the entire groups; while a Cecidomyiid on oak, the stalk borer and several other species have received special attention individually.

The erection of a new greenhouse during the summer has greatly improved the facilities of the division for entomological research, besides being an excellent example of modern greenhouse construction. With a house which is reasonably tight and which can be kept warm during the winter it has been possible to begin a series of experiments to determine the resistant power of various forcing crops to fumigation. The business of raising crops under glass in Massachusetts is a very large one, and in too many places is greatly interfered with by the presence of insects which can only be controlled by fumigation with hydrocyanic acid gas. The strength of fumigation necessary to destroy these insects is now well known in most cases, but the charge which the plants can resist under all conditions of growth is not; and many an owner has refused to fumigate a badly infested house for fear of killing his plants along with the insects. From the experiments now under way, and which it will require several years to complete, it is believed that data can be obtained of such a nature that any person who desires to treat a greenhouse will be able to do so with entire safety to the plants, and yet kill the insects which may be present.

Insects of the Year.

The present year has been favorable for the rapid increase of insects in Massachusetts, and, though no one species has been present in overwhelming abundance, each has done its part in attacking crops of all kinds.

The San José scale is as abundant as it has ever been in the State, and is spreading farther each year. Where its presence is neglected it makes itself speedily felt; but with the methods we now have for its control there is no reason why it should be more than a nuisance in the future, requiring treatment every two or three years, like any of our other pests.

Cutworms and wire worms have given much trouble, particularly in the eastern and central portions of the State, while but little has been heard of root maggots this season.

The army worm has caused considerable injury locally on some of the cranberry bogs and elsewhere in southeastern Massachusetts, and in the central and western parts of the State the moths of this pest have been more abundant than for some time. It has now been nearly ten years since the last outbreak of this insect, and it is not unlikely that another may be due before long, if unknown factors do not develop to prevent it.

Inquiries about insects have covered a wider range than usual, but the most numerous questions have been about several species of scale insects, plant lice of different kinds, red spiders, borers, datanas, the bean weevil and the red-humped apple-tree caterpillar.

Since the Legislature placed the work on the gypsy and brown-tail moths in the hands of a special commission, no particular attention has been given them here; but some facts observed in connection with their distribution are here noted, as they have been gathered by members of the station. A few tents of the brown-tail moth were observed in Amherst last spring and others were received from Martha's Vineyard, while several were found on Nantucket last fall, showing that this insect is widely distributed over the State. Several cases have also been reported to the station of the presence of the gypsy moth outside of the territory originally occupied by it, and these observations have been confirmed by inspectors of the Gypsy Moth Commission. That this insect is now rapidly spreading there can be no doubt, and it is too probable that the entire State will before long be infested by these two insects, which are among the worst enemies to man which occur in the United States.

APPENDIX.

Compilation of Analyses of Agricultural Chemicals, Refuse Salts, Ashes, Lime Compounds, Refuse Substances, Guanos, Phosphates and Animal Excrements.

H. D. HASKINS.

1. Chemicals, refuse salts, etc.
2. Ashes, marls, lime compounds, etc.
3. Refuse substances.
4. Guanos, phosphates, etc.
5. Animal excrement, etc.
6. Average per cents. of the different ingredients found in the preceding compilation of analyses, calculated to pounds per ton of 2,000 pounds.

1868 to 1905.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the different bulletins and annual reports of the State inspector of fertilizers from 1873 to 1895, which are contained in the reports of the secretary of the Massachusetts State Board of Agriculture for these years, and in the bulletins of the division of chemistry of the Hatch Experiment Station of the Massachusetts Agricultural College since March, 1895.

No valuation is stated in this compilation, as the basis of valuation changes from year to year.

In the following compilation of analyses of agricultural chemicals, refuse materials, manurial substances, etc., the signification of the star (*) prefixed to the name of the substance is that the compilation is made up of analyses subsequent to the year 1897. It was believed that a compilation made up of more recent analyses would more nearly represent the present general chemical character of the substances, and would therefore be of more practical value.

It must be understood that the chemical character of many of the refuse substances used for manurial purposes is constantly undergoing changes, due to frequent variations in the parent industry.

As a rule, in all succeeding analyses the essential constituents are determined and stated; blanks do not imply the absence of the non-essentials.

1. *Chemicals, Refuse Salts, etc.*

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
* Carbonate of potash, high grade,	6	3.38	-	-	-	-	67.20	55.68	60.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* Carbonate of potash and magnesia,	2	18.22	-	-	-	-	20.00	18.48	19.24	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Carnalite,	1	-	-	-	-	-	-	-	13.68	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
* Kainit,	9	2.18	-	-	-	-	13.65	10.90	12.47	-	-	-	-	-	-	18.97	2.37	6.37	-	20.25	-	20.64	2.13
Krugite,	1	4.82	-		-	-	-	-	8.42	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
* Muriate of potash,	70	1.56	-	-	-	-	54.80	45.40	49.89	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
* Nitrate of potash,	5	.98	-	14.58	11.60	13.30	45.62	43.88	44.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* Nitrate of soda,	93	1.52	-	16.57	14.14	15.47	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
* Nitre lime,	2	.92	-	-	-	8.42	-	-	-	-	-	-	-	-	-	-	29.30	-	-	-	-	-	2.28
Nitre salt cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Phosphate of potash,	1	3.76	-	-	-	-	-	-	32.55	-	-	37.50	-	37.50	-	-	-	-	-	13.43	-	-	.92
Phosphate of ammonia,	1	6.05	-	-	-	10.37	-	-	-	-	-	43.86	-	-	-	-	-	-	-	12.46	-	-	.82
* Refuse from manufacture of cyanide of potash,	1	39.23	-	-	-	.96	-	-	7.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* Sulfate of ammonia,	23	.99	-	22.16	19.44	20.74	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
* Sulfate of potash, high grade,	48	.82	-	-	-	-	53.15	45.70	49.25	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
* Sulfate of potash-magnesia,	24	3.83	-	-	-	-	31.68	19.55	25.34	-	-	-	-	-	-	6.25	2.57	13.86	-	44.72	-	1.95	2.26

1. *Chemicals, Refuse Salts, etc.* — Concluded.

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
* Silicate of potash,	4	7.86	-	-	-	-	27.62	21.48	20.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* Sulfate of magnesia,	10	23.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.40	-	36.10	-	-	5.73
* Sulfate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste,	12	2.54	-	3.30	.52	2.22	30.94	1.55	13.66	-	-	-	-	-	-	37.04	.75	.19	-	1.85	-	46.25	-
* Vegetable potash,	6	3.63	-	-	-	-	27.84	23.96	25.95	-	-	2.55	-	-	-	-	20.65	-	-	-	-	-	9.70

2. *Ashes, Marls, Lime Compounds, etc.*

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
* Acetylene gas-tank refuse,	1	4.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.15	-	-	-	-	-	-
Ashes of spent tan bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Ashes from cremation of swill,	15	4.86	-	-	-	-	8.83	1.25	3.97	32.36	7.47	14.16	-	-	-	-	33.58	1.87	4.65	-	-	-	21.57
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
* Ashes from cremation of garbage,	3	3.01	-	-	-	-	6.01	3.72	5.13	10.21	7.16	8.77	-	-	-	15.65	20.22	1.16	9.22	4.57	10.85	4.75	28.42
* Ashes from hay and straw,	1	.40	-	-	-	-	-	-	1.55	-	-	1.02	-	-	-	-	5.22	-	-	-	-	-	66.35
* Ashes from jute waste,	1	.19	-	-	-	-	-	-	.51	-	-	.54	-	-	-	3.84	6.04	.39	7.60	-	-	.57	81.02
* Ashes from peach tree trimmings,	1	.54	-	-	-	-	-	-	4.92	-	-	2.44	-	-	-	7.53	18.74	-	10.50	2.20	-	-	13.54
* Ashes from soft coal and sawdust,	1	3.36	-	-	-	-	-	-	.73	-	-	.74	-	-	-	-	2.80	-	-	-	-	-	69.53

Ammoniated marl,	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
* Bleachery refuse,	2	4.19	-	-	-	-	1.24	.35	.79	-	-	-	-	-	-	11.69	35.79	-	-	-	-	-	23.09
Bituminous coal ashes,	2	3.66	-	-	-	-	-	-	.38	-	-	.44	-	-	-	-	1.88	-	-	-	-	-	74.17
* Brick-yard ashes,	2	.58	-	-	-	-	3.59	3.32	3.45	1.61	1.33	1.47	-	-	-	-	24.33	-	-	-	-	-	47.63
* Coal and wood ashes,	1	1.32	-	-	-	-	-	-	.44	-	-	1.15	-	-	-	-	2.39	-	-	-	-	-	80.94
* Cotton-seed hull ashes,	33	7.31	-	-	-	-	32.80	14.08	22.53	15.53	6.26	8.49	-	6.88	1.28	-	7.03	12.64	-	7.31	-	-	17.12
* Corn-cob ashes,	2	5.47	-	-	-	1.18	42.38	7.08	24.73	7.08	2.37	4.72	-	-	-	-	7.00	-	-	-	-	-	38.12
* Carbonate of lime,	2	.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.31	-	-	-	-	-	-
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
* Gas-house lime,	5	11.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48.19	8.30	-	19.66	-	-	8.99
Green sand marl (Virginia),	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
* Hemp ashes,	1	-[1]	-	-	-	-	-	-	2.48	-	-	1.74	-	-	-	-	60.47	-	-	-	-	-	3.14
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
* Lime refuse from soda factory,	1	24.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.86	-	1.36	23.14	-	-	1.63
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime,	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.63	-	-	-	-	-	1.33
* Lime-kiln ashes,	10	11.35	-	-	-	-	4.73	.43	2.04	1.58	.03	.78	-	-	-	-	41.49	1.30	-	-	-	-	6.78
* Leather-scrap ashes,	3	5.94	-	-	-	.15	3.36	1.00	2.23	3.96	1.80	2.89	-	-	-	-	7.80	-	-	-	-	-	46.08
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.56
Magnolia ashes (Florida),	1	1.58	-	-	-	-	-	-	2.56	-	-	.45	-	-	-	-	-	-	-	-	-	-	6.12
Massachusetts marls,	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44

[1] None.

2. *Ashes, Marls, Lime Compounds, etc.* — Concluded.

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
* Marl,	1	15.54	–	–	–	.01	–	–	.29	–	–	.02	–	–	–	–	–[1]	–	–	–	–	–	–
Marl (North Carolina),	1	.70	–	–	–	–	–	–	.04	–	–	.56	–	–	–	–	21.95	.61	–	–	–	–	50.18
* Nova Scotia plaster (gypsum),	17	6.45	–	–	–	–	–	–	–	–	–	–	–	–	–	–	33.74	.75	–	44.87	–	–	5.79
Olive earth (Virginia),	1	1.97	–	–	–	–	–	–	.24	–	–	13.73	–	–	–	–	19.16	–	6.00	–	–	–	50.55
Onondaga plaster (New York gypsum),	4	13.27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30.00	4.66	–	32.50	8.20	–	9.83
* Oyster-shell lime,	2	–[2]	–	–	–	–	–	–	–	–	–	.38	–	–	–	–	55.54	–	–	–	9.45	–	8.82
* Picker-waste ashes,	1	.28	–	–	–	–	–	–	6.56	–	–	1.18	–	–	–	–	–	–	–	–	–	–	63.43
* Patent-process lime,	1	–[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	57.87	–	–	–	–	–	9.03
* Prepared lime,	1	–[2]	–	–	–	–	–	–	–	–	–	–	–	–	–	3.99	69.48	.50	1.50	–	–	–	–
* Pine-wood ashes,	1	2.76	–	–	–	–	–	–	4.37	–	–	3.07	–	–	–	–	23.61	–	–	–	–	–	37.46
* Peat,	5	45.30	20.47	1.88	.34	.92	–	–	.04	.11	–[1]	.08	–	–	–	–	.88	–	–	–	–	–	16.23
* Plastering,	1	7.20	–	–	–	–	–	–	–	–	–	.22	–	–	–	–	11.50	–	–	–	–	–	66.50
Peat ashes,	1	4.67	–	–	–	–	–	–	.46	–	–	.11	–	–	–	–	2.28	1.63	6.13	–	–	–	45.17
* Pulp ashes,	1	–[2]	–	–	–	–	–	–	.46	–	–	.12	–	–	–	–	67.72	–	–	–	–	–	7.00
Railroad-tie ashes,	1	4.70	–	–	–	–	–	–	.92	–	–	.56	–	–	–	–	2.51	–	–	–	–	–	80.20
* Refuse ashes from sawdust,	1	13.92	–	–	–	–	–	–	3.58	–	–	7.92	–	–	–	–	34.76	–	–	–	–	–	25.27

Sea-weed ashes, ...	1	1.47	–	–	–	–	–	–	.92	–	–	.30	–	–	–	8.76	6.06	4.37	–	2.98	–	6.60	68.65
* Tan-bark ashes, ...	1	1.50	–	–	–	–	–	–	.52	–	–	.77	–	–	–	–	24.29	–	–	–	–	–	13.54
* Wood ashes, ...	5.55	12.08	–	–	–	–	13.58	1.12	5.42	6.07	.06	1.42	–	–	–	–	32.98	3.31	7.43	–	–	–	16.51
* Wool-waste ashes, ...	1	8.40	–	–	–	–	–	–	27.24	–	–	.26	–	–	–	–	2.88	–	–	–	–	–	27.82
* Wood charcoal, ...	2	3.65	–	–	–	–	–	–	.40	–	–	.16	–	–	–	–	–	–	–	–	–	–	1.58
* Walnut-wood ashes, ...	1	3.79	–	–	–	–	–	–	5.06	–	–	2.07	–	–	–	–	40.73	–	–	–	–	–	2.29
* Waste lime from tannery, ...	2	.88	–	–	–	.65	–	–	–	–	–	–	–	–	–	–	54.78	–	–	–	–	–	2.83
* Waste lime, ...	1	.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	74.12	–	–	–	–	–	.38
Virginia marls, ...	2	15.98	–	–	–	–	.61	.37	.49	.09	.08	.09	–	–	–	–	7.25	.21	–	.66	7.25	–	64.23

3. *Refuse Substances.*

Ammoniate, ...	1	5.88	–	–	–	11.33	–	–	–	–	–	3.43	–	–	–	–	–	–	–	–	–	–	1.38
* Blood and bone, ...	5	5.97	–	7.19	5.70	6.23	–	–	–	12.86	11.38	12.14	–	4.41	7.73	–	–	–	–	–	–	–	–
* Bone dust, ...	1	5.06	–	–	–	3.06	–	–	–	–	–	17.80	–	7.24	10.56	–	–	–	–	–	–	–	–
Bone soup, ...	1	82.92	7.07	–	–	1.14	–	–	–	–	–	1.26	–	–	–	–	–	–	–	–	–	–	–
* Bone from fish, ...	1	8.78	–	–	–	4.82	–	–	–	–	–	23.54	–	8.04	15.50	–	–	–	–	–	–	–	–
* Broom-corn seed, ...	1	7.40	–	–	–	1.51	–	–	.50	–	–	.57	–	–	–	–	–	–	–	–	–	–	–
* Banana skins, ...	1	13.99	–	–	–	.24	–	–	5.46	–	–	1.80	–	–	–	–	–	–	–	–	–	–	–
Blue-green algæ (*Lyngbia Majasculas*),	1	16.26	–	–	–	4.25	–	–	.79	–	–	.19	–	–	–	3.53	2.06	1.18	–	–	–	–	5.53
* Burned bone, ...	5	2.06	–	–	–	–	–	–	–	–	–	37.33	–	2.71	35.66	–	52.12	–	–	–	–	–	.96
* Cocoanut-fibre pith, ...	1	6.20	3.78	–	–	.34	–	–	.84	–	–	.03	–	–	–	–	.57	–	–	–	–	–	1.01

[1] Trace. [2] None.

3. *Refuse Substances* — Continued.

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
*Cocoa shells,	1	3.88	–	–	–	2.33	–	–	2.48	–	–	.36	–	–	–	–	.76	–	–	–	–	–	–
*Concentrated wool washings,	1	41.13	–	–	–	1.09	–	–	10.15	–	–	.10	–	–	–	–	–	–	–	–	–	–	–
*Condensed bone steam,	1	81.75	–	–	–	1.94	–	–	–	–	–	.07	–	–	–	–	–	–	–	–	–	–	–
*Castor-bean pomace,	6	7.64	5.70	5.85	4.68	5.18	3.40	.64	1.20	2.26	1.57	2.12	–	–	–	–	.87	.29	–	–	–	–	1.75
*Cassava waste,	1	9.03	–	–	–	.33	–	–	.28	–	–	.06	–	–	–	–	.61	–	–	–	–	–	–
*Cotton-seed meal,	1.27	6.85	–	–	7.99	3.24	6.74	1.92	1.41	1.64	3.30	1.71	2.56	–	–	–	–	–	–	–	–	–	.28
*Cotton-seed dust,	1	4.38	–	–	–	1.22	–	–	1.48	–	–	.54	–	–	–	–	1.48	–	–	–	–	–	–
*Cotton-seed droppings,	1	4.08	–	–	–	.96	–	–	1.85	–	–	.20	–	–	–	–	.66	–	–	–	–	–	–
*Cotton compost,	1	42.51	–	–	–	–	.93	–	–	.56	–	–	.39	–	–	–	–	–	–	–	–	–	–
*Cotton waste, wet,	4	24.02	34.42	1.34	.84	1.21	.76	.43	.64	.74	.56	.65	–	–	–	–	2.73	–	–	–	–	–	38.16
*Cork dust,	1	.74	–	–	–	.59	–	–	.33	–	–	.10	–	–	–	–	.74	.08	–	–	–	–	.24
*Coral formation,	1	39.26	–	–	–	.28	–	–	.14	–	–	.21	–	–	–	–	23.14	1.39	–	–	–	–	16.98
*Cotton waste, dry,	9	6.45	13.57	1.60	.55	1.03	1.62	.48	1.13	.66	.08	.32	–	–	–	–	1.73	–	–	–	–	–	14.61
Cotton dust,	2	32.68	50.93	–	–	.78	–	–	.45	–	–	.32	–	–	–	–	–	–	–	–	–	–	42.22
*Dried blood,	34	10.45	6.37	13.55	7.99	10.16	–	–	–	8.70	.03	2.50	–	–	–	–	–	–	–	–	–	–	–
Dried soup from meat and bone,	1	14.80	8.40	–	–	9.97	–	–	–	–	–	.53	–	–	–	–	–	–	–	–	–	–	.64

Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
* Dry ground fish,	59	8.87	-	10.48	6.06	8.36	-	-	-	16.07	5.50	8.87	-	4.64	4.18	-	-	-	-	-	-	-	-
* Damaged grain,	3	42.15	-	1.97	.84	1.44	.43	.16	.28	.83	.35	.55	-	-	-	-	-	-	-	-	-	-	-
* Deposit from Charles River,	1	21.46	-	-	-	.95	-	-	.59	-	-	.74	-	-	-	-	1.81	-	-	-	-	-	44.27
* Dredgings from Cape Cod,	1	18.99	-	-	-	.99	-	-	.13	-	-	.07	-	-	-	-	-	-	2.06	-	-	.54	-
* Deposit from pond,	1	4.01	-	-	-	.41	-	-	.26	-	-	.32	-	-	-	-	1.62	-	-	-	-	-	-
Eel grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
* Factory waste,	5	13.11	32.20	2.95	.47	1.55	11.78	.18	3.57	1.07	.29	.60	-	.24	-	-	13.02	-	-	6.73	-	-	6.14
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
* Fibre waste,	1	61.53	-	-	-	.22	-	-	.49	-	-	.10	-	-	-	-	.36	-	-	-	-	-	.53
* Fleshings,	1	6.96	43.14	-	-	7.55	-	-	-	-	-	.31	-	-	-	-	-	-	-	-	-	-	-
* Fresh-cut bone,	1	24.98	-	-	-	3.00	-	-	-	-	-	16.85	-	5.26	11.59	-	-	-	-	-	-	-	-
Fish with 20 to 40 per cent. water,	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than 40 per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
* Garbage tankage,	1	2.12	-	-	-	5.95	-	-	-	-	-	6.06	-	4.40	1.66	-	-	-	-	-	-	-	-
* German peat moss,	1	9.50	1.14	-	-	.72	-	-	.06	-	-	.05	-	-	-	-	.21	-	-	-	-	-	.36
* Ground tobacco stems,	8	8.84	20.20	2.72	.99	2.02	8.18	3.88	6.15	1.15	.32	.62	-	-	-	-	6.75	-	-	-	-	-	1.30
Ground bone, damaged by salt water,	1	32.81	-	-	-	1.78	-	-	-	-	-	17.21	-	5.26	11.95	-	-	-	-	-	-	-	-
* Ground bones,	2.53	5.03	66.14	5.94	.85	3.06	-	-	-	31.42	14.50	24.34	-	8.52	15.82	-	-	-	-	-	-	-	1.08
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-

3. *Refuse Substances* — Continued.

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
* Hoof meal,	1	4.10	–	–	–	15.19	–	–	–	–	–	.77	–	–	–	–	–	–	–	–	–	–	–
* Horn dust,	3	8.63	–	–	–	14.60	–	–	–	–	–	.04	–	–	–	–	–	–	–	–	–	–	–
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	–	–	–	2.30	1.36	1.83	–	–	–	–	–	–	–	–	–	–	.24
* Hair waste,	1	6.52	22.77	–	–	9.22	–	–	.14	–	–	.51	–	–	–	4.10	–	–	–	–	–	–	–
* Hop refuse,	2	84.56	1.71	.69	.49	.59	.06	.05	.05	.11	.10	.10	–	–	–	–	–	–	–	–	–	–	.83
Ivory dust,	1	11.50	52.63	–	–	6.64	–	–	–	–	–	24.56	.97	17.97	5.62	–	–	–	–	–	–	–	–
* Jadoo fibre,	2	10.20	11.60	.97	.77	.87	.48	.38	.43	1.24	.26	.75	–	–	–	–	3.50	–	–	–	–	–	4.05
Jute waste,	1	13.10	–	–	–	1.50	–	–	.08	–	–	.72	–	–	–	–	–	–	–	–	–	–	–
* Kiln dust from brewery,	1	9.72	–	–	–	4.32	–	–	2.16	–	–	.96	–	–	–	–	.78	–	–	–	–	–	7.11
* Linseed meal,	7	8.65	–	6.42	5.26	5.78	1.58	1.46	1.52	1.59	1.36	1.47	–	–	–	–	–	–	–	–	–	–	.58
Lobster shells,	1	7.27	–	–	–	4.50	–	–	–	–	–	3.52	–	–	–	–	22.24	1.30	–	–	–	–	.27
* Meat meal,	1	3.22	8.55	–	–	9.23	–	–	–	–	–	3.08	–	–	–	–	–	–	–	–	–	–	–
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	–	–	–	3.58	.56	2.07	–	–	–	–	–	–	–	–	–	–	.58
Meat scrap,	2	24.79	–	–	–	6.33	–	–	–	–	–	5.79	–	–	–	–	–	–	–	–	–	–	–
Morocco factory waste,	1	22.72	–	–	–	1.16	–	–	.36	–	–	2.56	–	–	–	–	19.60	–	–	1.24	–	–	24.17
* Meat and bone,	12	8.64	–	–	–	5.29	–	–	–	–	13.78	16.81	–	7.06	9.74	–	–	–	–	–	–	–	–

Mill sweepings,	1	9.49	–	–	–	3.76	–	–	.66	–	–	1.18	–	–	–	–	–	–	–	–	–	–	5.01
* Mill waste,	1	4.50	–	–	–	1.84	–	–	.58	–	–	1.07	–	–	–	–	–	–	–	–	–	–	–
Madder,	2	11.93	–	–	–	.91	–	–	2.40	–	–	.35	–	–	–	–	3.93	.51	–	–	–	–	4.67
* Milk cassein,	1	7.15	–	–	–	7.30	–	–	.76	–	–	8.06	–	–	–	–	11.78	–	1.40	–	–	–	.10
Mussel mud, wet,	1	60.01	27.29	–	–	.21	–	–	6.17	–	–	.10	–	–	–	.70	.93	.14	3.48	–	–	–	
Mussel mud, dry,	1	2.24	72.02	–	–	.72	–	–	–	–	–	.35	–	–	–	–	23.39	–	8.26	–	–	–	37.60
* Muck and peat, wet,	28	67.58	9.97	1.35	.12	.46	.16	.02	.05	.19	.01	.06	–	–	–	–	.37	–	–	–	–	–	6.73
* Muck and peat, dry,	8	6.67	69.54	2.10	.26	.84	–	–	–	–	–	.31	–	–	–	–	.77	–	–	–	–	–	–
* Mud,	3	42.02	44.76	.65	.19	.35	–	–	.15	–	–	.02	–	–	–	–	.09	–	–	–	–	–	–
Oleomargarine refuse,	1	8.54	14.42	–	–	12.12	–	–	–	–	–	.88	–	–	–	–	–	–	–	–	–	–	.96
* Paper-mill dustings,	1	1.68	23.41	–	–	.35	–	–	.60	–	–	.13	–	–	–	–	.30	–	4.40	–	–	–	14.23
* Product from garbage plant,	1	4.14	–	–	–	2.56	–	–	.50	–	–	6.92	–	–	–	–	–	–	–	–	–	–	16.48
Pine barren grass,	1	8.48	2.40	–	–	.16	–	–	.07	–	–	.18	–	–	–	–	–	–	–	–	–	–	1.67
Pine needles,	1	9.48	3.42	–	–	.46	–	–	.03	–	–	.12	–	–	–	–	–	–	–	–	–	–	1.22
* Rawhide dust,	1	14.50	–	–	–	13.91	–	–	–	–	–	1.06	–	–	–	–	–	–	–	–	–	–	–
Raw wool,	1	6.95	7.54	–	–	12.88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.63
Rotten brewers' grain,	1	78.77	–	–	–	.72	–	–	.04	–	–	.43	–	–	–	–	.26	.15	–	–	–	–	.59
Refuse from calico works,	1	4.07	–	–	–	4.28	–	–	–	–	–	11.95	–	–	–	–	–	–	–	–	–	–	–
* Refuse from glucose factory,	1	.13	–	–	–	–	–	–	–	–	–	42.76	–	2.88	39.88	–	38.78	–	2.92	3.00	–	–	–
* Refuse from glass factory,	1	16.48	–	–	–	–	–	–	19.50	–	–	–	–	–	–	6.12	–	–	–	–	–	–	–
Residue from water filter,	1	94.22	–	–	–	.12	–	–	–	–	–	.05	–	–	–	–	–	–	–	–	–	–	–
Rockweed, green,	1	68.50	23.70	–	–	.62	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

3. *Refuse Substances* — Concluded.

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
Rockweed, dry,	2	13.73	35.75	1.45	1.07	1.26	4.89	1.56	3.22	2.75	.14	1.44	–	–	–	5.97	4.88	.96	1.22	–	–	.16	–
* Salt marsh mud,	5	60.05	32.32	.28	.18	.24	–	–	.14	–	–	.08	–	–	–	–	.11	–	–	–	–	2.06	37.88
* Silt deposit,	1	7.15	–	–	–	1.14	–	–	.39	–	–	.25	–	–	–	–	.70	–	–	–	–	–	–
Sponge refuse,	1	7.25	–	–	–	2.43	–	–	–	–	–	3.19	–	–	–	–	3.94	1.27	–	–	–	–	39.05
* Sizing paste,	2	62.28	–	2.13	1.13	1.63	–	–	–	.34	.02	.18	–	–	–	–	–	–	–	–	–	–	–
* Sizing waste,	1	74.00	–	–	–	.01	–	–	.40	–	–	–	.01	–	–	–	–	–	–	–	–	–	1.43
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	–	–	–	15.37	11.04	13.21	–	–	–	–	–	–	–	–	–	–	1.29
Soup from horse rendering,	1	92.14	–	–	–	1.12	–	–	–	–	–	.14	–	–	–	–	–	–	–	–	–	–	–
* Spent brewers' grain,	1	73.10	–	–	–	1.23	–	–	.07	–	–	.33	–	–	–	–	–	–	–	–	–	–	–
* Spent bone-black,	1	1.16	–	–	–	–	–	–	–	–	–	31.02	–	1.96	29.06	–	–	–	–	–	–	–	–
* Sugar-beet refuse,	1	7.70	–	–	–	6.39	–	–	9.72	–	–	–[1]	–	–	–	7.00	–[1]	–	–	2.82	–[1]	1.87	–
Sumac waste,	1	63.06	6.80	–	–	1.19	–	–	3.25	–	–	–	–	–	–	–	1.14	3.25	–	–	–	–	2.25
Starch waste from rubber factory,	1	10.01	.23	–	–	.02	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
* Sludge from sewage beds,	1	36.95	30.97	–	–	1.07	–	–	.20	–	–	.28	–	–	–	–	4.34	–	2.62	–	–	–	37.80
* Sludge from sewage-precipitating tanks.	4	37.74	–	1.31	.46	.91	.66	.07	.25	.86	.39	.61	–	–	–	–	3.10	2.19	8.55	.41	4.86	–	28.70
* Sewage,	4	54.11	72.89	1.04	.30	.55	.44	.09	.27	.42	.40	.63	–	–	–	–	–	2.79	–	–	–	.03	35.87

Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
*Soot,	2	8.60	-	-	-	.77	1.57	.17	.87	.72	.23	.47	-	-	-	-	2.92	1.19	6.38	-	-	-	71.07
*Tankage,	76	8.02	-	11.27	4.11	5.88	-	-	-	21.62	.76	14.00	-	6.37	7.50	-	-	-	-	-	-	-	-
*Tobacco dust,	5	5.04	58.68	2.25	1.54	1.80	6.81	1.53	2.93	1.28	.36	.61	-	-	-	-	3.09	-	-	-	-	-	31.18
Tobacco leaves,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
*Tobacco stems,	2	10.15	23.76	2.20	1.99	2.09	8.68	5.72	7.20	1.02	.32	.67	-	-	-	-	5.46	-	-	-	-	-	2.70
*Tobacco stalks exposed to the action of weather.	2	7.62	-	1.40	1.18	1.29	4.01	.52	2.26	.92	.38	.65	-	-	-	-	-	-	-	-	-	-	1.86
*Teopik fibre,	1	56.54	-	-	-	.53	-	-	1.26	-	-	.55	-	-	-	-	5.15	-	-	-	-	-	.75
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*Undried tankage,	1	29.00	-	-	-	1.06	-	-	-	-	-	3.51	-	2.94	.51	-	-	-	-	-	-	-	-
*Vegetable mould,	1	26.07	-	-	-	.62	-	-	.66	-	-	.45	-	-	-	-	-	-	-	-	-	-	-
*Wool dustings,	1	14.10	16.04	-	-	3.65	-	-	.29	-	-	.32	-	-	-	-	1.02	-	-	-	-	-	9.25
*Wool waste,	13	10.71	30.12	8.30	.39	3.05	5.92	.29	1.68	1.02	.05	.56	-	-	-	-	2.39	-	-	-	-	-	31.58
Wool washings, water,	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
*Wool waste and sheep manure,	1	7.13	-	-	-	2.63	-	-	2.20	-	-	.64	-	-	-	-	-	-	-	-	-	-	-
Wool washings, acid,	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings, alkaline,	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
*Whalebone scrapings,	1	6.90	-	-	-	13.01	-	-	-	-	-	.26	-	-	-	-	-	-	-	-	-	-	-
*Water abstract of dry forest leaves,	1	99.46	.16	-	-	.004	-	-	.03	-	-	.022	-	-	-	-	.025	-	-	-	-	-	-

[1] None.

4. *Guanos, Phosphates, etc.*

Fertilizer Materials.	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
* Acid phosphate,	44	10.61	–	–	–	–	–	–	–	19.16	11.60	15.75	9.53	3.87	2.35	–	–	–	–	–	–	–	–
* Apatite,	2	.07	–	–	–	–	–	–	–	37.74	32.62	35.18	–	2.09	33.09	–	–	–	–	–	–	–	–
* Belgian phosphate,	1	.21	–	–	–	–	–	–	–	–	–	9.54	–	–	–	–	41.27	–	–	–	–	–	–
* Bone ash,	1	.34	–	–	–	–	–	–	–	–	–	39.14	–	–	–	–	–	–	–	–	–	–	–
Bone-black,	5	4.60	–	–	–	–	–	–	–	30.54	16.56	28.28	–	–	–	–	–	–	–	–	–	–	3.64
Brockville phosphate,	1	2.50	–	–	–	–	–	–	–	–	–	35.21	–	–	–	–	–	–	–	–	–	–	6 46
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	6.47	–	–	1.31	6.53	1.00	3.76	–	–	–	–	–	–	–	–	–	–	2.00
Bat guano from Florida,	2	15.66	–	–	–	9.74	–	–	1.77	3.44	3.26	3.35	–	–	–	–	–	–	–	–	–	–	19.33
* Bat guano from Havana, Cuba,	2	5.83	–	6.96	1.70	4.33	1.20	.53	.86	14.00	5.04	9.52	–	–	–	6.17	11.04	–	5.76	–	–	–	9.47
Cuban guano,	5	24.27	–	2.74	.63	1.67	–	–	–	16.16	11.54	13.35	–	–	–	–	–	–	–	–	–	–	3.17
Caribbean guano (orchilla),	12	7.31	–	–	–	–	–	–	–	35.43	18.11	26.77	–	–	–	–	39.95	3.29	–	2.68	–	–	1.27
* Dissolved bone-black,	38	11.60	–	–	–	–	–	–	–	20.93	15.60	17.56	12.98	3.40	1.18	–	–	–	–	–	–	–	–
* Double superphosphate,	2	6.27	–	–	–	–	–	–	–	50.14	45.42	47.78	18.36	20.97	8.45	–	–	–	–	–	–	–	–
* Dissolved bone meal,	9	6.47	–	4.64	1.66	2.14	–	–	–	22.26	14.58	16.42	3.95	8.45	4.02	–	–	–	–	–	–	–	–
* Damaraland guano,	1	17.70	–	–	–	5.79	–	–	3.53	–	–	14.78	4.90	5.79	4.09	7.03	14.21	2.05	–	5.94	–	5.77	9.26
* Florida rock phosphate,	2	.53	–	–	–	–	–	–	–	40.34	33.10	36.72	–	.10	36.62	–	–	–	–	–	–	–	–
* Florida soft phosphate,	1	4.46	–	–	–	–	–	–	–	–	–	26.48	–	.38	26.10	–	–	–	–	–	–	–	–
* Mona Island guano,	1	13.32	–	–	–	.76	–	–	–	–	–	21.88	–	7.55	14.33	–	37.49	–	–	–	–	–	2.45

* Novassa phosphate,	1	5.77	–	–	–	–	–	–	–	–	–	24.56	–	1.66	22.90	–	–	–	–	–	–	–	–
Odorless phosphate,	6	2.99	–	–	–	–	.52	.04	.38	21.74	18.40	19.54	–	.52	19.82	–	51.42	–	–	–	2.51	–	9.14
* Phosphatic slag,	9	.57	–	–	–	–	–	–	–	21.78	14.71	17.73	–	5.27	12.46	–	39.60	–	–	–	–	–	–
* Peruvian guano,	30	13.58	37.61	13.50	4.44	6.36	4.08	1.14	2.62	20.60	5.96	14.85	3.72	5.49	5.64	–	12.85	–	–	–	–	–	6.60
Rat guano from Florida,	1	10.32	–	–	–	3.32	–	–	6.85	–	–	2.30	–	–	–	–	–	–	–	–	–	–	1.15
* South Carolina rock phosphate,	5	.80	–	–	–	–	–	–	–	31.87	25.58	28.06	–	3.40	24.60	–	–	–	–	–	–	–	–
South Carolina floats,	1	.83	–	–	–	–	–	–	–	–	–	23.39	–	2.33	21.06	–	–	–	–	–	–	–	20.16
South American bone ash,	1	7.00	–	–	–	–	–	–	–	–	–	35.89	–	–	–	–	44.89	–	–	–	–	–	4.50
* Tennessee phosphate,	1	.37	–	–	–	–	–	–	.44	–	–	33.00	–	–	–	–	–	–	–	–	–	–	–
Upton phosphate,	1	9.07	–	–	–	–	–	–	–	–	–	40.15	–	37.84	2.31	–	–	–	–	–	–	–	–

5. *Animal Excrement, etc.*

* Barnyard manure,	38	73.38	8.29	.69	.18	.42	.92	.25	.53	.59	.10	.31	–	–	–	–	–	–	–	–	–	–	5.57
* Compost,	1	1.70	–	–	–	.79	–	–	.97	–	–	.56	–	–	–	–	–	–	–	–	–	–	–
Drainage from manure heap,	1	93.20	3.66	–	–	.98	–	–	.88	–	–	.24	–	–	–	–	–	–	–	–	–	–	–
Goose manure,	1	48.92	–	–	–	.21	–	–	.81	–	–	.95	–	–	–	–	–	–	–	–	–	–	–
* Guinea-pig manure,	1	8.35	–	–	–	1.74	–	–	1.66	–	–	.55	–	–	–	–	.39	–	–	–	–	–	3.78
* Hen manure,	4	43.21	–	1.83	.42	.87	2.96	.43	1.11	3.93	.63	1.62	–	–	–	–	1.19	.89	–	1.24	–	–	23.09
Hen-house refuse,	2	7.37	–	–	–	.71	–	–	1.03	–	–	1.02	–	–	–	–	–	–	–	–	–	–	71.07
Horse manure,	1	11.24	–	–	–	.74	–	–	2.82	–	–	1.46	–	–	–	–	–	–	–	–	–	–	12.60
* Liquid manure,	1	96.56	–	–	–	.56	–	–	.02	–	–	.01	–	–	–	–	–	–	–	–	–	–	–
Poudrette, dry,	1	5.25	35.45	–	–	3.58	–	–	.49	–	–	5.74	–	–	–	–	–	–	–	–	–	–	4.65
* Sheep manure,	10	8.33	17.60	2.97	.85	2.19	3.42	.68	2.13	2.24	.22	1.46	–	–	–	–	3.36	–	–	–	–	–	28.49

6. Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds.

FERTILIZER MATERIALS.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
1. Chemicals, Refuse Salts, etc.													
*Carbonate of potash, high grade,	67.6	-	-	1,218.4	-	-	-	-	-	-	-	-	-
*Carbonate of potash,	364.4	-	-	384.8	-	-	-	390.4	-	-	-	-	7.8
Carnalite,	-	-	-	274	-	153	-	264	-	11	-	831	-
*Kainit,	63.6	-	-	249.4	-	379.4	47.4	127.4	-	405	-	412.8	42.6
Krugite,	96	-	-	168	-	105	249	176	-	639	-	133	299
*Muriate of potash,	31.2	-	-	997.8	-	133.8	-	11	-	-	-	976	14
*Nitrate of potash,	19.6	-	266	891.4	-	-	-	-	-	-	-	-	-
*Nitrate of soda,	30.4	-	309.4	-	-	710	-	-	-	-	-	10	10
*Nitre lime,	18.4	-	168.4	-	-	-	586	-	-	-	-	-	45.6
Nitre salt cake,	121	-	46	17	-	591	-	-	-	955	-	-	78
Phosphate of potash,	75	-	-	651	750	-	-	-	-	269	-	-	18
Phosphate of ammonia,	121	-	207	-	877	-	-	-	-	249	-	-	16
*Potash refuse from manufacture of cyanide of potash,	785	-	19	147	-	-	-	-	-	-	-	-	-
*Sulfate of ammonia,	19.8	-	414.8	-	-	-	-	-	-	1,200	-	-	-

* Sulfate of potash,	16.4	-	-	985	-	89.2	-	30	-	914.4	-	-	.15
* Sulfate of potash-magnesium,	76.6	-	-	506.8	-	125	51.4	277.2	-	894.4	-	39	45.2
* Silicate of potash,	157.2	-	-	411.8	-	-	-	-	-	-	-	-	-
* Sulfate of magnesia,	475	-	-	-	-	-	56	348	-	722	-	-	115
* Sulfate of soda,	28	-	-	-	-	-	-	-	-	1,189	-	-	-
Saltpetre waste,	51	-	44	273	-	741	15	4	-	37	-	925	-
* Vegetable potash,	72.6	-	-	519	51	-	413	-	-	-	-	-	194
2. Ashes, Marls, Lime Compounds, etc.													
Acetylene gas-tank refuse,	84	-	-	-	-	-	1,183	-	-	-	-	-	-
Ashes of spent tan bark,	97	-	-	36	27	-	622	68	36	-	-	-	504
Ashes from cremation of swill,	97	-	-	79	283	-	672	37	93	-	-	-	431
Ashes from blue works,	243	1,276	-	180	-	-	-	-	-	-	-	-	246
* Ashes from cremation of garbage,	60	-	-	103	175	313	404	23	184	91	217	95	568
* Ashes from hay and straw,	8	-	-	31	20	-	104	-	-	-	-	-	1,327
* Ashes from jute waste,	4	-	-	10	11	77	121	8	152	-	-	11	1,620
* Ashes from peach-tree trimmings,	11	-	-	98	49	151	375	-	210	44	-	-	271
* Ashes from soft coal and sawdust,	67.2	-	-	14.6	14.8	-	56	-	-	-	-	-	1,390.6
Ammoniated marl,	66	-	32	-	208	-	-	-	-	-	-	-	-
* Bleachery refuse,	84	-	-	16	-	234	716	-	-	-	-	-	462
Bituminous coal ashes,	73	-	-	8	9	-	38	-	-	-	-	-	1,483
* Brick-yard ashes,	11.6	-	-	69	29.4	-	486.6	-	-	-	-	-	952.6
* Coal and wood ashes,	26.4	-	-	8.80	23	-	47.8	-	-	-	-	-	1,618.8

6. Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

Fertilizer Materials.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
2. *Ashes, Marls, Lime Compounds, etc.* — Con.													
* Cotton-seed hull ashes,	146.2	–	–	450.6	169.8	–	160.6	252.8	–	–	–	–	342.4
* Corn-cob ashes,	109.4	–	23.6	494.6	94.4	–	140	–	25.6	–	–	–	762.4
* Carbonate of lime,	9	–	–	–	–	–	1,046.2	–	–	–	–	–	–
Gypse,	33	–	–	–	–	–	1,017	–	–	–	–	–	57
Gas-house lime,	223.2	–	–	–	–	–	963.8	166	–	393.2	–	–	179.8
Green sand marl (Virginia),	25	–	–	23	187	–	516	–	103	–	–	–	826
* Hemp ashes,	–[1]	–	–	49.6	34.8	–	1,209.4	–	–	–	–	–	63.8
Hard-pine wood ashes,	15	–	–	203	45	–	499	–	–	–	–	–	598
* Lime refuse from soda factory,	481	–	–	–	–	–	297	–	27	463	–	–	33
Lime waste from sugar factory,	726	–	–	4	45	–	550	–	–	–	–	–	6
Lime,	–	–	–	–	–	–	1,873	–	–	–	–	–	27
* Lime-kiln ashes,	227	–	–	40.8	15.6	–	829.8	26	–	–	–	–	135.6
* Leather-scrap ashes,	118.8	–	3	44.6	57.8	–	156	–	–	–	–	–	921.6
Logwood ashes,	30	–	–	2	46	–	78	–	–	–	–	–	194

Mill ashes,	11	-	-	32	9	-	699	27	-	-	-	-	727
Magnolia ashes (Florida),	32	-	-	51	9	-	-	-	-	-	-	-	122
Massachusetts marls,	274	-	-	5	21	-	810	13	14	-	571	-	69
* Marl,	310.8	-	.02	5.80	.40	-	-[2]	-	-	-	-	-	-
Marl (North Carolina),	14	-	-	1	11	-	439	12	-	-	-	-	1,004
* Nova Scotia plaster (gypsum),	129	-	-	-	-	-	675	15	-	897	-	-	116
Olive earth (Virginia),	39	-	-	5	275	-	383	-	120	-	-	-	1,011
Onondaga plaster (New York gypsum),	265	-	-	-	-	-	600	93	-	650	164	-	197
* Oyster-shell lime,	-[1]	-	-	-	7.60	-	1,110.8	-	-	-	189	-	176.4
* Picker-waste ashes,	6	-	-	131	24	-	-	-	-	-	-	-	1,269
* Patent-process lime,	-[1]	-	-	-	-	-	1,157.4	-	-	-	-	-	180.6
Peat ashes,	93	-	-	9	2	-	46	33	123	-	-	-	903
* Prepared lime,	-[1]	-	-	-	-	79.8	1,389.6	10	31	-	-	-	-
* Pine-wood ashes,	55.2	-	-	87.4	61.4	-	472.2	-	-	-	-	-	749.2
* Peat,	906	409.4	18.4	.8	1.6	-	17.6	-	-	-	-	-	324.6
* Plastering,	144	-	-	-	4.40	-	2.30	-	-	-	-	-	13.30
* Pulp ashes,	-[1]	-	-	9.2	2.4	-	1,354.4	-	-	-	-	-	140
Railroad-tie ashes,	94	-	-	18	11	-	50	-	-	-	-	-	1,604
* Refuse ashes from sawdust,	278.4	-	-	71.6	154.4	-	695.2	-	-	-	-	-	505.4
Sea-weed ashes,	29	-	-	18	6	175	121	87	-	60	-	132	1,273
* Tan-bark ashes,	30	-	-	10.4	15.4	-	485.8	-	-	-	-	-	270.8

[1] None. [2] Trace.

6. Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

Fertilizer Materials.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
2. Ashes, Marls, Lime Compounds, etc. — Con.													
Virginia marls,	320	–	–	10	2	–	145	.4	–	13	145	–	1,285
* Waste lime,	16	–	–	–	–	–	1,482	–	–	–	–	–	8
* Waste lime from tannery,	17.6	–	13.13	–	–	–	1,083.6	–	–	–	–	–	76.6
* Walnut-wood ashes,	75.8	–	–	101.2	41.4	–	814.6	–	–	–	–	–	45.8
* Wood ashes,	241.6	–	–	184	28.4	–	659.6	66.2	148.6	–	–	–	330.2
* Wool-waste ashes,	168	–	–	544.8	5.2	–	57.6	–	–	–	–	–	556.4
* Wood charcoal,	73	–	–	8	3.2	–	–	–	–	–	–	–	31.6
3. Refuse Substances.													
Ammoniate,	118	–	227	–	69	–	–	–	–	–	–	–	28
* Blood and bone,	119	–	125	–	243	–	–	–	–	–	–	–	–
Bone soup,	1,658	141	23	–	25	–	–	–	–	–	–	–	–
* Bone from fish,	176	–	96	–	471	–	–	–	–	–	–	–	–
* Broom-corn seed,	148	–	30	10	11	–	–	–	–	–	–	–	–
* Bone dust,	101	–	61.2	–	356	–	–	–	–	–	–	–	–

* Banana skins,	280	–	5	109	36	–	–	–	–	–	–	–	–
Blue-green algæ (*Lyngbia majuscula*),	325	–	85	16	4	71	41	24	–	–	–	–	111
* Burned bone,	41.2	–	–	–	746.6	–	1,042.4	–	–	–	–	–	19.2
* Cassava waste,	180.6	–	6.60	5.60	1.20	–	12.20	–	–	–	–	–	–
* Coral formation,	785.2	–	5.6	2.8	4.2	–	462.8	27.8	–	–	–	–	339.6
* Cocoanut-fibre pith,	124	75.60	6.80	16.80	.06	–	11.4	–	–	–	–	–	20.2
* Cotton compost,	850.2	–	18.6	11.2	7.8	–	–	–	–	–	–	–	–
* Cotton-seed dust,	87.6	–	24.4	29.6	10.8	–	29.6	–	–	–	–	–	–
* Cotton-seed droppings,	81.6	–	19.2	37	4	–	13.2	–	–	–	–	–	–
* Cocoa shells,	77.6	–	46.6	49.6	7.2	–	15.2	–	–	–	–	–	–
* Cotton waste, dry,	129	271.4	20.6	–	6.4	–	34.6	–	–	–	–	–	292.2
* Concentrated wool washings,	823	–	22	203	2	–	–	–	–	–	–	–	–
* Condensed bone steam,	1,635	–	39	–	1	–	–	–	–	–	–	–	–
* Castor-bean pomace,	157.2	114	103.6	24	42.4	–	17.4	6.8	–	–	–	–	35
* Cotton-seed meal,	137	–	134.8	32.8	51.2	–	–	–	–	–	–	–	5.6
* Cork dust,	15	–	12	7	2	–	15	2	–	–	–	–	5
* Cotton waste, wet,	480.4	688.4	24.2	12.8	13	–	54.6	–	–	–	–	–	763.2
Cotton dust,	654	1,019	16	9	6	–	–	–	–	–	–	–	844
Dried soup from meat and bone,	296	168	199	–	11	–	–	–	–	–	–	–	13
Dried soup from rendering cattle feet,	216	150	289	–	9	–	–	–	–	–	–	–	5
* Dried blood,	209	–	203.2	–	50	–	–	–	–	–	–	–	–
* Dry ground fish,	177.4	–	167.2	–	177.4	–	–	–	–	–	–	–	–

6. Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

Fertilizer Materials.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
3. Refuse Substances — Con.													
* Damaged grain,	843	-	29	6	11	-	-	-	-	-	-	-	-
* Deposit from Charles River,	429	-	19	12	15	-	36	-	-	-	-	-	885
* Dredgings from Cape Cod,	380	-	20	3	1	-	-	-	41	-	-	11	-
* Deposit from pond,	80	-	8	5	6	-	12	-	-	-	-	-	-
Eel grass,	708	312	17	18	6	33	43	2	-	-	-	-	21
Felt refuse,	585	671	105	-	-	-	-	-	-	-	-	-	-
* Fleshings,	139	863	151	-	6	-	-	-	-	-	-	-	-
* Fresh-cut bone,	500	-	60	-	337	-	-	-	-	-	-	-	-
* Factory waste,	262.2	644	31	71.4	12	-	260.4	-	-	134.6	-	-	122.8
* Fibre waste,	1,230.6	-	4.4	9.8	2	-	7.2	-	-	-	-	-	11.6
Fish with 20 to 40 per cent. water,	604	412	119	-	142	-	-	-	-	-	-	-	34
Fish with more than 40 per cent. water,	909	310	99	-	112	-	-	-	-	-	-	-	27
Fresh-water mud,	807	-	27	4	5	-	25	6	36	-	-	-	365
* Garbage tankage,	42.4	-	119	-	121.2	-	-	-	-	-	-	-	-

* Ground bone, damaged by salt water,	656.2	-	35.6	-	344.2	-	-	-	-	-	-	-	-
* Ground tobacco stems,	177	404	40	123	12	-	135	-	-	-	-	-	26
* Ground bones,	120.6	1,282.8	61.2	-	486.8	-	-	-	-	-	-	-	21.6
Glucose refuse,	162	-	52	3	6	-	4	4	-	-	-	-	1
German peat moss,	190	22.8	14.4	1.2	1	-	4.2	-	-	-	-	-	7.2
Horn shavings,	97	-	306	-	8	-	-	-	-	-	-	-	-
* Horn dust,	172.6	-	292	-	.8	-	-	-	-	-	-	-	-
* Hoof meal,	82	-	304	-	15	-	-	-	-	-	-	-	-
Horn and hoof waste,	203	153	265	-	37	-	-	-	-	-	-	-	5
* Hair waste,	130	455	184	3	10	82	-	-	-	-	-	-	-
* Hop refuse,	1,691	34	12	1	2	-	-	-	-	-	-	-	17
Ivory dust,	230	1,053	133	-	491	-	-	-	-	-	-	-	-
* Jadoo fibre,	204	232	17.4	8.6	15	-	70	-	-	-	-	-	81
Jute waste,	262	-	30	2	14	-	-	-	-	-	-	-	-
* Kiln dust from brewery,	194	-	86	43	19	-	16	-	-	-	-	-	142
* Linseed meal,	173	-	115.6	30.4	29.4	-	-	-	-	-	-	-	11.6
Lobster shells,	145	-	90	-	70	-	445	26	-	-	-	-	5
* Meat meal,	64	171	185	-	62	-	-	-	-	-	-	-	-
Meat mass,	242	272	209	-	41	-	-	-	-	-	-	-	12
Meat scrap,	496	-	127	-	116	-	-	-	-	-	-	-	-
Morocco factory waste,	454	-	23	7	51	-	392	-	-	25	-	-	483
* Meat and bone,	172.8	-	105.8	-	336.2	-	-	-	-	-	-	-	-

6. *Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds* — Continued.

Fertilizer Materials.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
3. *Refuse Substances* — Con.													
* Mill waste,	90	-	26.8	11.6	21.4	-	-	-	-	-	-	-	-
Mill sweepings,	190	-	75	13	24	-	-	-	-	-	-	-	100
* Milk cassein,	143	-	146	15.2	161.2	-	235.6	-	28	-	-	-	2
Madder,	239	-	18	48	7	-	79	10	-	-	-	-	93
Mussel mud, wet,	1,200	546	4	123	2	14	19	3	70	-	-	-	-
Mussel mud, dry,	45	1,440	14	-	7	-	468	-	165	-	-	-	752
* Muck and peat, wet,	1,351.6	199.4	9.2	1	1.2	-	7.40	-	-	-	-	-	134.6
* Muck and peat, dry,	133	1,391	17	-	6	-	15	-	-	-	-	-	-
* Mud,	840.4	895.2	7	3	4	-	1.8	-	-	-	-	-	-
Oleomargarine refuse,	171	288	242	-	18	-	-	-	-	-	-	-	19
* Paper-mill dustings,	133.6	468.2	7	12	2.6	-	6	-	-	88	-	-	284.6
* Product from garbage plant,	83	51	-	10	138	-	-	-	-	-	-	-	330
Pine barren grass,	170	48	3	1	4	-	-	-	-	-	-	-	33
Pine needles,	190	68	9	1	2	-	-	-	-	-	-	-	24

Raw wool,	139	151	258	-	-	-	-	-	-	-	-	-	73
*Rawhide dust,	290	-	278.2	-	21.2	-	-	-	-	-	-	-	-
Rotten brewers' grain,	1,575	-	14	1	9	-	5	3	-	-	-	-	12
Refuse from calico works,	81	-	86	-	239	-	-	-	-	-	-	-	-
*Refuse from glucose factory,	3	-	-	-	855	-	776	-	58	60	-	-	-
*Refuse from glass factory,	330	-	-	390	-	122	-	-	-	-	-	-	-
Rockweed, green,	1,370	474	12	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	274.6	715	25.2	64.4	28.8	119.4	97.6	19.2	24.4	-	-	3.2	-
Residue from water filter,	1,884	-	2	-	1	-	-	-	-	-	-	-	-
*Silt deposit,	143	-	22.8	7.8	5	-	14	-	-	-	-	-	-
Sponge refuse,	145	-	49	-	64	-	79	25	-	-	-	-	781
*Sizing paste,	1,245.6	-	32.6	3.6	-	-	-	-	-	-	-	-	-
*Sizing waste,	1,480	-	.2	8	.2	-	-	-	-	-	-	-	29
*Sludge from sewage beds,	739	619.4	21.4	4	5.6	-	86.8	-	52.4	-	-	-	75.6
Soap-grease refuse,	585	1,028	22	-	3	-	-	-	-	-	-	-	26
Soup from horse rendering,	1,462	-	24.6	1.4	6.6	-	-	-	-	-	-	-	-
*Spent brewers' grain,	1,842.8	-	22.4	2.8	-	-	-	-	-	-	-	-	-
*Spent bone-black,	23	-	-	-	620	-	-	-	-	-	-	-	-
*Sugar-beet refuse,	154	-	127.8	194.4	-[1]	140	-[1]	-	-	56.4	-[1]	37.4	-
Sumac waste,	1,261	136	24	65	-	-	23	65	-	-	-	-	45
Starch waste from rubber factory,	200	5	.4	-	-	-	-	-	-	-	-	-	-

1 None.

6. *Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds* — Continued.

FERTILIZER MATERIALS.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
3. *Refuse Substances* — Con.													
* Sludge from sewage-precipitating tanks,	755	-	18	5	12	-	62	44	171	8	97	-	574
* Sewage,	1,082.2	1,452.8	11	5.4	12.6	-	-	-	55.8	-	-	6.6	617.4
Salt mud,	1,067	824	8	7	-	19	18	7	83	-	-	-	698
* Salt marsh mud,	1,201	646.4	4.8	2.8	1.6	-	2.2	-	-	-	-	41.2	757.6
* Soot,	172	-	15	17	9	-	58	24	128	-	-	-	1,421
* Tankage,	160.4	-	117.6	-	28.0	-	-	-	-	-	-	-	-
* Tobacco dust,	100.8	1,173.6	36	58.6	12.2	-	61.8	-	-	-	-	-	623.6
* Tobacco stems,	203	475.2	41.8	144	13.4	-	109.2	-	-	-	-	-	54
Tobacco leaves,	261	420	55	145	9	-	83	43	6	-	-	-	83
* Tobacco stalks exposed to the action of weather,	152.4	-	25.8	45.2	13	-	-	-	-	-	-	-	37.2
* Teopik fibre,	1,131	-	11	25	11	-	103	-	-	-	-	-	15
Turf,	386	127	39	-	-	-	-	-	-	-	-	-	-
* Undried tankage,	580	-	21	-	70	-	-	-	-	-	-	-	-
* Wool waste,	214.2	602.4	61	33.6	11.2	-	47.8	-	-	-	-	-	601.6

* Wool dustings,	282	320.8	73	5.8	6.4	-	20.4	-	-	-	-	-	185
Wool washings, water,	-	-	-	7.8	-	10	6	-	-	-	-	-	-
Wool washings, acid,	-	-	-	8.4	-	8	12	.4	-	-	-	-	-
Wool washings, alkaline,	1,841	66	2	22	-	18	1	-	-	-	-	-	4
Whale meat, raw,	890	21	9.7	-	-	-	-	-	-	-	-	-	-
* Wool waste and sheep manure,	142.6	-	52.6	44	12.8	-	-	-	-	-	-	-	-
Waste from lactate factory,	682	-	14	-	13	-	452	-	-	-	-	-	138
* Whalebone scrapings,	14	-	260	-	5	-	-	-	-	-	-	-	-
* Water abstract of dry forest leaves,	1,989	3	.08	.6	.44	-	.5	-	-	-	-	-	-
Vegetable mould,	521.4	-	12.4	13.2	9	-	-	-	-	-	-	-	-
4. Guanos, Phosphates, etc.													
* Acid phosphate,	212.2	-	-	-	315	-	-	-	-	-	-	-	-
* Apatite,	1	-	-	-	704	-	-	-	-	-	-	-	-
* Bone ash,	7	-	-	-	783	-	-	-	-	-	-	-	-
* Belgian phosphate,	4.2	-	-	-	190.8	-	825.4	-	-	-	-	-	-
Bone-black,	92	-	-	-	566	-	-	-	-	-	-	-	73
Brockville phosphate,	5.0	-	-	-	70.4	-	-	-	-	-	-	-	129
Bat guano from Texas,	80.2	365	129	26	75	-	-	-	-	-	-	-	40
Bat guano from Florida,	313	-	195	35	67	-	-	-	-	-	-	-	387
* Bat guano from Havana, Cuba,	116.6	-	86.6	17.2	90.4	123.4	220.8	-	115.2	-	-	-	189.4
Cuban guano,	485	-	33	-	267	-	-	-	-	-	-	-	63
Caribbean guano (orchilla),	146	-	-	-	535	-	799	66	-	54	-	-	25

6. Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Concluded.

FERTILIZER MATERIALS.	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Sodium Oxide.	Calcium Oxide (Lime).	Magnesium Oxide.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
4. Guanos, Phosphates, etc. — Con.													
* Dissolved bone-black,	232	-	-	-	351.2	-	-	-	-	-	-	-	-
* Double superphosphate,	125	-	-	-	956	-	-	-	-	-	-	-	-
* Dissolved bone meal,	129.4	-	428	-	328.4	-	-	-	-	-	-	-	-
* Damaraland guano,	354	-	116	71	296	141	284	41	-	119	-	115	185
* Florida rock phosphate,	11	-	-	-	734	-	-	-	-	-	-	-	-
* Florida soft phosphate,	89	-	-	-	530	-	-	-	-	-	-	-	-
* Mona Island guano,	266	-	15	-	438	-	750	-	-	-	-	-	49
* Novassa phosphate,	115	-	-	-	491	-	-	-	-	-	-	-	-
Odorless phosphate,	60	-	-	8	391	-	1,028	-	-	-	50	-	183
* Phosphatic slag,	11.4	-	-	-	354.6	-	792	-	-	-	-	-	-
Peruvian guano,	271.6	752.2	127.2	52.4	247	-	257	-	-	-	-	-	132
Rat guano from Florida,	206	-	66	137	46	-	-	-	-	-	-	-	23
* South Carolina rock phosphate,	16	-	-	-	561.2	-	-	-	-	-	-	-	-
South Carolina floats,	17	-	-	-	468	-	-	-	-	-	-	-	403

South American bone ash,	14.0	-	-	-	718	-	898	-	-	-	-	-	90
*Tennessee phosphate,	7	-	-	9	660	-	-	-	-	-	-	-	-
Upton phosphate,	181	-	-	-	803	-	-	-	-	-	-	-	-
5. Animal Excrement, etc.													
*Barnyard manure,	1,466.6	165.8	8.4	10.6	6.2	-	-	-	-	-	-	-	111.4
*Compost,	34	-	15.8	19.4	11.2	-	-	-	-	-	-	-	-
Drainage from manure heap,	1,864	73	19.6	17.6	48	-	-	-	-	-	-	-	-
Goose manure,	978	-	4.2	16.2	19	-	-	-	-	-	-	-	-
*Hen manure,	864.2	-	17.4	22.2	32.4	-	238	17.8	-	24.8	-	-	461.8
Hen-house refuse,	147	-	14.2	20.6	20.4	-	-	-	-	-	-	-	1,421
Horse manure,	225	-	14.8	56.4	29.2	-	-	-	-	-	-	-	252
Guinea-pig manure,	167	-	34.8	33.2	11	-	7.8	-	-	-	-	-	75.6
*Liquid manure,	1,931.2	-	11.2	.4	.2	-	-	-	-	-	-	-	-
Poudrette, dry,	105	709	71.6	9.8	115	-	-	-	-	-	-	-	93
*Sheep manure,	166.6	352	43.8	42.6	29.2	-	67.2	-	-	-	-	-	569.8

Compilation of Analyses of Fruits, Garden Crops and Insecticides.

H. D. HASKINS.

1. Analyses of fruits.
2. Analyses of garden crops.
3. Relative proportions of phosphoric acid, potassium oxide and nitrogen in fruits and garden crops.
4. Analyses of insecticides.

The results of chemical analyses of twenty prominent garden crops (green) show the following average composition, expressed in parts per thousand : —

Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

A computation of the results of the above analyses of green garden vegetables shows the following relative proportion of the three essential ingredients of plant food : —

Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

The weight and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one. (C. A. Goessmann.)

1. Analyses of Fruits.

Fertilizing Constituents of Fruits (Parts per Thousand).

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Ericaceæ: —										
* Cranberries,	996	–	1.8	.9	.1	.3	.1	.3	–	–
* Cranberries,	894	.8	–	1.0	–	.2	.1	.3	–	–
Rosaceæ: —										
Apples,	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
* Apples,	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
* Peaches,	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears,	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–
Strawberries,	902	–	3.3	.7	.9	.5	–	.5	.1	.1
* Strawberries,	–	–	5.2	2.6	.2	.7	.4	1.0	–	–

Fertilizing Constituents of Fruits — Concluded.

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Rosaceæ — *Con.*										
* Strawberry vines,	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Cherries,	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
Plums,	838	–	2.9	1.7	–	.3	.2	.4	.1	–
Saxifragaceæ: —										
* Currants, white,	–	–	5.9	3.1	.2	1.0	.3	1.1	–	–
* Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	–	–
Viticeæ: —										
Grapes,	830	1.7	8.8	5.0	.1	1.0	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

2. Analyses of Garden Crops.

Fertilizing Constituents of Garden Crops (Parts per Thousand).

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ: —										
Mangolds,	880	1.8	9.1	4.8	1.5	.3	.4	.8	.3	.9
* Mangolds,	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–
Mangold leaves,	905	3.0	14.6	4.5	2.8	1.6	1.4	1.0	.8	2.3
Sugar beets,	805	1.6	7.1	3.8	.6	.4	.6	.9	.3	.3
* Sugar beets,	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Sugar beet tops,	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Sugar beet leaves,	897	3.0	15.3	4.0	2.0	3.1	1.7	.7	.8	1.3
Sugar beet seed,	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
* Red beets,	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–

Fertilizing Constituents of Garden Crops — Continued.

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ — *Con.*										
Spinach,	903	2.4	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
* Spinach,	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositæ: —										
Lettuce, common,	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Head lettuce,	943	2.2	10.3	3.9	.8	1.5	.6	1.0	.4	.8
* Head lettuce,	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Roman lettuce,	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4
Artichoke,	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
* Artichoke, Jerusalem,	775	4.6	–	4.8	–	–	–	1.7	–	–

Convolvulaceæ : —										
Sweet potato,	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ : —										
White turnips,	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
* White turnips,	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
White turnip leaves,	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2
* Ruta-bagas,	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Savoy cabbage,	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
White cabbage,	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
* White cabbage,	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cabbage leaves,	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cauliflower,	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish,	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	4.5	.3	.5
Kohlrabi,	850	4.8	12.3	4.3	.8	.4	.8	2.7	1.1	.6

Fertilizing Constituents of Garden Crops — Continued.

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Cucurbitaceæ : —										
Cucumbers,	956	1.6	5.8	2.4	·6	.4	.2	1.2	.4	.4
Pumpkins,	900	1.1	4.4	.9	.9	.3	.2	.7	.3	.4
Gramineæ : —										
Corn, whole plant, green,	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5
* Corn, whole plant, green,	786	4.1	–	3.8	.5	1.5	.9	1.5	–	–
Corn, kernels,	144	16.0	12.4	3.7	.1	.3	1.9	5.7	.1	.2
* Corn, kernels,	100	18.2	–	4.0	.3	.3	2.1	7.0	–	–
* Corn, whole ears,	90	14.1	–	4.7	.6	.2	1.8	5.7	–	–
* Corn stover,	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	–	–

Leguminosæ: —										
Hay of peas cut green,	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
* Cow-pea (*Dolichos*), green,	788	2.9	–	3.1	.6	3.0	1.0	1.0	–	–
* Small pea (*Lathyrus Sylvestris*), dry,	90	38.5	–	25.7	4.7	17.9	5.0	9.0	–	–
Peas, seed,	143	35.8	23.4	10.1	.2	1.1	1.9	8.4	.8	.4
Pea straw,	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Garden beans, seed,	150	39.0	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Bean straw,	166	–	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
* Velvet beans, kernel,	111.6	31.1	–	13.2	–	–	–	7.7	–	–
* Velvet beans, with pod,	115.2	19.6	–	13.1	–	–	–	8.4	–	–
* Leaves and stems of velvet beans,	58.8	28.6	–	–	–	–	–	–	–	–
Liliaceæ: —										
* Asparagus,	942	3.3	–	3.29	–	–	–	1.08	–	–
Asparagus,	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3

Fertilizing Constituents of Garden Crops — Concluded.

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Liliaceæ — *Con.*										
Onions, ...	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
* Onions, ...	892	–	4.9	1.8	.1	.4	.2	.7	–	–
Solanaceæ: —										
Potatoes, ...	750	3.4	9.5	5.8	.3	.3	.5	1.6	.6	.3
* Potatoes, ...	798	2.1	9.9	2.9	.1	.1	.2	.7	–	–
Potato tops, nearly ripe, ...	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe, ...	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
* Tomatoes, ...	940	1.7	–	3.6	–	.3	.2	.4	–	–
Tobacco leaves, ...	180	34.8	140.7	40.7	4.5	50.7	10.4	6.6	8.5	9.4

* Tobacco, whole leaf,	103.1	24.3	–	57.9	24.7	45.8	13.8	4.3	16.3	1.59
Tobacco stalks,	180	24.6	64.7	28.2	6.6	12.4	.5	9.2	2.2	2.4
* Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	–	–
Umbelliferæ: —										
Carrots,	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.5	.4
* Carrots,	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops,	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry,	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Parsnips,	793	5.4	10.0	.4	.2	1.1	.6	1.9	.5	.4
* Parsnips,	803	2.2	–	6.2	.1	.9	.5	1.9	–	–
Celery,	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8

Many of the foregoing analyses were compiled from the tables of E. Wolff. Those marked with a star (*) are from analyses made at the Massachusetts State Agricultural Experiment Station, Amherst, Mass., and since 1895, at the chemical division of the Hatch Experiment Station of the Massachusetts Agricultural College.

3. Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits and Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Fruits.			
Ericaceæ: —			
* Cranberries, ...	1	3.0	–
* Cranberries, ...	1	3.33	2.66
Rosaceæ: —			
Apples, ...	1	2.7	2.0
* Apples, ...	1	1.9	1.3
* Peaches, ...	1	1.3	–
Pears, ...	1	3.6	1.2
Strawberries, . . .	1	1.4	–
* Strawberries, . . .	1	2.6	–
* Strawberry vines, . .	1	.7	–
Cherries, ...	1	3.3	–
Plums, ...	1	4.3	–
Saxifragaceæ: —			
* Currants, white, . . .	1	2.8	–
* Currants, red, . . .	1	2.1	–
Gooseberries, . . .	1	1.9	–

3. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Continued.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Viticeæ: —			
Grapes, ...	1	3.6	1.2
Grape seed, ...	1	1.0	2.7
Garden Crops.			
Chenopodiaceæ: —			
Mangolds, ...	1	6.0	2.3
* Mangolds, ...	1	4.2	2.1
Mangold leaves, . . .	1	4.5	3.0
Sugar beets, ...	1	4.2	1.8
* Sugar beets, ...	1	4.8	2.2
Sugar beet tops, . . .	1	2.3	1.7
Sugar beet leaves, . .	1	5.7	4.3
Sugar beet seed, . . .	1	1.5	–
* Red beets, ...	1	4.1	3.3
Spinach, ...	1	1.7	3.1
* Spinach, ...	1	19.2	6.8
Compositæ: —			
Lettuce, common, . . .	1	5.3	–
Head lettuce, . . .	1	3.9	2.2
* Head lettuce, . . .	1	7.7	4.0
Roman lettuce, . . .	1	2.3	1.8
Artichoke, ...	1	.63	–
* Artichoke, Jerusalem, . .	1	2.8	2.7

3. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Continued.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Convolvulaceæ: —			
Sweet potato, . . .	1	4.6	3.0
Cruciferæ: —			
White turnips, . . .	1	3.6	2.3
* White turnips, . . .	1	3.9	1.8
White turnip leaves, . .	1	3.1	3.3
* Ruta-bagas, ...	1	4.1	1.6
Savoy cabbage, . . .	1	1.9	2.5
White cabbage, . . .	1	4.1	1.7
* White cabbage, . . .	1	11.0	7.6
Cabbage leaves, . . .	1	4.1	1.7
Cauliflower, ...	1	2.3	2.5
Horse-radish, . . .	1	3.9	2.2
Radishes, ...	1	3.2	3.8
Kohlrabi, ...	1	1.6	1.8
Cucurbitaceæ: —			
Cucumbers, ...	1	2.0	1.3
Pumpkins, ...	1	.6	.7
Gramineæ: —			
Corn, whole plant, green, .	1	3.7	1.9
* Corn, whole plant, green, .	1	2.2	2.8
Corn, kernels, . . .	1	.6	2.8
* Corn, kernels, . . .	1	.6	2.6

3. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Continued.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Gramineæ — *Con.*			
* Corn, whole ears, . . .	1	.8	2.5
* Corn, stover, . . .	1	4.4	3.7
Leguminosæ: —			
Hay of peas, cut green, .	1	3.4	3.4
* Cow-pea (*Dolichos*), green, .	1	3.1	2.9
* Small pea (*Lathyrus sylvestris*), dry.	1	3.4	4.2
Peas, seed, ...	1	1.2	4.3
Pea straw, ...	1	2.8	4.0
Garden beans, seed, . .	1	1.2	4.0
Bean straw, ...	1	3.3	–
* Velvet beans, kernel, . .	1	1.7	4.0
* Velvet beans, with pod, .	1	1.56	2.3
* Leaves and stems of velvet beans.	–	–	–
Liliaceæ: —			
* Asparagus, ...	1	3.05	3.06
Asparagus, ...	1	1.3	3.6
Onions, ...	1	1.9	2.1
* Onions, ...	1	2.6	–
Solanaceæ: —			
Potatoes, ...	1	3.6	2.1
* Potatoes, ...	1	4.1	3.0
Potato tops, nearly ripe, .	1	2.7	3.1

3. Relative Proportions of Phosphoric Acid, etc., in Fruits and Garden Crops — *Concluded.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Solanaceæ — *Con.*			
Potato tops, unripe, . .	1	3.7	5.3
* Tomatoes, ...	1	8.7	4.5
Tobacco leaves, . . .	1	6.2	5.3
* Tobacco, whole leaf, . .	1	13.46	5.65
Tobacco stalks, . . .	1	3.1	2.7
* Tobacco stems, . . .	1	10.7	3.8
Umbelliferæ : —			
Carrots, ...	1	2.7	2.0
* Carrots, ...	1	5.7	1.7
Carrot tops, ...	1	2.9	5.1
Carrot tops, dry, . . .	1	8.0	5.1
Parsnips, ...	1	3.8	2.8
* Parsnips, ...	1	3.3	1.2
Celery, ...	1	3.5	1.1

4. Analyses of Insecticides.

	Moisture.	Arsenious Oxide.	Copper Oxide.	Lead Oxide.	Zinc Oxide.	Barium Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter in Hydrochloric Acid.
Average of twenty analyses, Paris green,	.88	59.00	30.89	-	-	-	4.74	-	-	-	-	-	-	-	-	.20
Average of four analyses, "Lion brand, new-process Paris green."	4.64	54.91	7.93	-	-	-	-	-	-	-	6.65	-	15.76	.35	-	1.00
Average of fourteen analyses of Paris green collected in the general markets in 1900-01.	.81	57.73	29.45	-	-	-	-	-	-	-	-	-	-	-	-	-
Pink arsenoid (lead arsenite),	.35	40.16	-	53.83	-	-	-	-	-	-	-	-	-	-	-	-
Green arsenoid (copper arsenite),	1.44	50.77	31.90	-	-	-	-	-	-	-	-	-	-	-	-	-
White arsenoid (barium arsenite),	2.35	31.90	-	.96	-	48.31	-	-	-	-	-	3.19	-	-	-	-
Laurel green,	7.64	7.34	13.50	-	-	-	-	-	-	-	-	-	26.31	-	-	-
Bug death,	.03	-	-	1.58	78.86	-	-	-	-	-	-	-	-	-	3.80	-
Sulphatine,	1.40	-	2.61	-	-	-	-	-	-	48.28	4.73	-	18.60	-	-	1.63
Death to rose bugs,	2.95	-	1.05	-	-	-	-	-	-	34.53	4.35	-	17.76	-	-	.49
Professor De Graff's carpet bug destroyer,	95.81	-	-	-	-	-	-	-	.78	-	.48	.27	-	.26	.90	-
Oriental fertilizer and bug destroyer,	87.14	2.38	-	-	-	-	-	-	-	-	.64	3.00	-	3.50	-	-
Non-poisonous potato bug destroyer,	-	-	-	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	-	-	-	2.12	-	-	-	-	3.07	6.55	.23	-
Tobacco liquor,	40.89	-	-	-	-	-	-	.53	-	-	-	-	1.47	16.34	.01	-
Tobacco liquor,	-	-	-	-	-	-	-	4.68	-	-	-	-	-	-	-	-
Nicotina,	10.00	-	-	-	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38.12
Peroxide of silicate,	1.65	.57	.33	-	-	-	-	-	-	-	49.66	-	41.18	-	-	2.31

Compilation of Analyses of Fodder Articles and Dairy Products, made at Amherst, Mass., 1868–1905.[1]

E. B. HOLLAND AND P. H. SMITH.

A. Composition and Digestibility of Fodder Articles.
- I. — Green fodders.
  - (*a*) Meadow grasses and millets.
  - (*b*) Cereal fodders.
  - (*c*) Legumes.
  - (*d*) Mixed and miscellaneous.
- II. — Silage.
- III. — Hay and dry, coarse fodders.
  - (*a*) Meadow grasses and millets.
  - (*b*) Cereal fodders.
  - (*c*) Legumes.
  - (*d*) Straw.
  - (*e*) Mixed and miscellaneous.
- IV. — Vegetables, fruits, etc.
- V. — Concentrated feeds.
  - (*a*) Protein.
  - (*b*) Starchy.
  - (*c*) Poultry.
- VI. — Dairy products.

B. Fertilizer Ingredients of Fodder Articles. (For classification, see A and C.)

C. Analyses of Dairy Products.

---

[1] Part III. of the report of Department of Foods and Feeding.

A. Composition and Digestibility of Fodder Articles.

[Figures equal percentages or pounds in 100.]

	Name.	Number of Analyses.	Composition.						Digestibility.			
			Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
	I. — Green Fodders.											
	(a) Meadow Grasses and Millets.											
	Johnson grass (*Andropogon halepensis*),	1	75	1.4	1.2	8.9	13.2	0.3	–	–	–	–
	Orchard grass (*Dactylis glomerata*),	7	70	2.1	2.9	10.4	13.7	0.9	–	–	–	–
	Tall oat grass (*Arrhenatherum elatius*),	4	70	1.6	2.3	10.8	14.7	0.6	–	–	–	–
Fox-tail millets.	Common millet (*Chætochloa Italica*),	16	80	1.0	1.5	6.5	10.5	0.5	0.9	4.6	7.0	0.3[1]
Fox-tail millets.	Canary bird seed millet (*C. Italica*),	1	80	1.6	1.0	7.1	10.0	0.3	–	–	–	–
Fox-tail millets.	Early harvest millet (*C. Italica*),	1	80	1.4	1.1	7.4	9.7	0.4	–	–	–	–
Fox-tail millets.	Golden millet (*C. Italica*),	1	80	1.2	0.8	7.0	10.7	0.3	–	–	–	–
Fox-tail millets.	Hungarian grass (*C. Italica*),	3	80	1.4	1.9	5.8	10.5	0.4	1.2	4.1	7.0	0.2
Fox-tail millets.	Japanese millet (*C. Italica*),	12	80	1.2	1.7	6.2	10.5	0.4	0.9	3.8	7.0	0.3
Broom-corn millets.	Millet (*Panicum miliaceum*),	1	80	1.1	1.1	5.3	11.7	0.8	–	–	–	–
Broom-corn millets.	Broom-corn millet (*P. miliaceum*),	1	80	1.2	1.3	6.4	10.7	0.4	–	–	–	–
Broom-corn millets.	Hog millet (*P. miliaceum*),	1	80	1.4	1.5	6.5	10.2	0.4	–	–	–	–
Broom-corn millets.	Japanese broom-corn millet (*P. miliaceum*),	2	80	1.2	0.9	6.2	11.4	0.3	–	–	–	–

[1] Same coefficients used as for Hungarian grass.

A. Composition and Digestibility of Fodder Articles — *Continued.*

Name.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
I.—Green Fodders—*Con.*											
(*a*) *Meadow Grasses and Millets*—Con.											
Barnyard millet (*Panicum crus-galli*),	8	80	1.7	1.9	6.6	9.4	0.4	1.2	4.8	6.7	0.2
Pearl millet (*Pennisetum spicatum*),	1	80	1.4	1.4	6.9	10.1	0.2	-	-	-	-
Japanese millet (variety uncertain),	3	80	1.1	1.2	7.1	10.2	0.4	0.6	4.4	6.8	0.3
(*b*) *Cereal Fodders.*											
Barley,	1	75	2.1	3.2	9.4	9.6	0.7	2.3	5.7	6.8	0.4
Barley in milk,	1	75	1.2	2.6	7.3	13.2	0.7	1.8	4.1	9.8	0.3
Corn fodder,	48	80	1.0	1.6	4.7	12.3	0.4	1.0	3.0	9.3	0.3
Sweet corn stover,	2	80	1.2	1.4	4.9	12.0	0.5	0.7	2.8	8.8	0.4 [1]
Oats (stage uncertain),	6	75	2.0	3.5	7.5	11.2	0.8	2.6	4.1	6.9	0.6 [2]
Oats in bloom,	1	75	1.7	1.6	1.9	12.0	0.7	1.1	5.0	7.4	0.5 [2]
Oats in milk,	1	75	1.5	2.7	8.6	11.5	0.7	2.0	4.7	7.1	0.5 [2]
Oats, ripe,	1	70	1.9	1.8	10.9	14.6	0.8	-	-	-	-
Rye,	2	75	1.4	1.9	8.0	13.2	0.5	1.5	6.4	9.4	0.4
Winter rye in bloom,	1	75	1.6	2.7	8.3	11.8	0.6	2.1	6.6	8.4	0.4

(c) *Legumes.*											
Alfalfa (*Medicago sativa*),	6	80	1.6	2.7	6.2	9.1	0.4	2.0	2.7	6.6	0.2
Horse bean (*Faba vulgaris*),	1	85	0.9	2.5	4.3	6.9	0.4	–	–	–	–
Soy bean (*Glycine hispida*),	14	80	2.1	3.5	5.4	8.1	0.9	2.7	2.4	6.2	0.5[3]
Soy bean (early white),	4	80	2.6	3.4	4.5	9.0	0.5	2.7	2.0	6.9	0.3
Soy bean (medium green),	16	80	2.2	4.1	5.3	7.8	0.6	3.2	2.4	6.0	0.3
Soy bean (medium green), in bud,	1	80	2.5	4.2	5.5	7.3	0.5	3.3	2.8	5.3	0.3
Soy bean (medium green), in blossom,	5	80	2.3	4.0	5.5	7.7	0.5	3.1	2.6	5.5	0.3
Soy bean (medium green), in pod,	9	78	2.3	4.5	5.9	8.6	0.7	3.5	2.7	6.6	0.4
Soy bean (medium black),	2	80	2.5	3.8	4.7	8.0	1.0	3.0	2.1	6.2	0.6
Soy bean (late),	4	80	2.6	4.6	4.2	8.0	0.6	3.6	1.9	6.2	0.3
Clover, alsike (*Trifolium hybridum*),	8	80	2.3	3.3	5.4	8.5	0.5	–	–	–	–
Clover, crimson (*T. incarnatum*),	2	80	2.8	3.1	6.0	7.6	0.5	2.4	3.4	5.6	0.3
Clover, mammoth red (*T. medium*),	4	80	1.9	3.0	5.8	8.9	0.4	–	–	–	–
Clover, medium red (*T. pratense*),	13	80	1.8	3.1	5.7	8.8	0.6	2.0	3.0	6.3	0.4
Clover, medium red, in bud,	2	80	2.1	3.6	4.7	9.0	0.6	2.4	2.5	6.6	0.4[4]
Clover, medium red, in blossom,	3	79	1.9	3.5	6.0	9.0	0.6	–	–	–	–
Clover, medium red, seedling,	2	75	2.3	3.8	7.2	11.0	0.7	2.4	3.7	7.2	0.4
Sweet clover (*Melilotus alba*).	4	80	1.9	3.8	6.3	7.4	0.6	–	–	–	–
Cow pea (*Vigna catjang*),	12	85	2.0	2.8	3.5	6.3	0.4	2.1	2.1	5.1	0.2[5]

1 Same coefficients used as for corn fodder.
2 Same coefficients applied to oats in several stages of growth.
3 Same coefficients applied to all soy beans except to medium green varieties in different stages of growth.
4 Coefficients taken from the German.
5 Same coefficients applied to all cow peas.

A. COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

NAME.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
I. — GREEN FODDERS — *Con.*											
(c) *Legumes* — Con.											
Cow pea, black,	4	85	2.3	3.1	3.4	5.9	0.3	2.4	2.0	4.8	0.2
Cow pea, Whip-poor-will,	5	85	1.9	2.5	3.7	6.6	0.3	1.9	2.2	5.3	0.2
Canada beauty pea (*Pisum arvense*),	1	85	1.2	2.4	4.4	6.6	0.4	–	–	–	–
Canada field pea (*P. arvense*),	8	85	1.3	3.2	4.3	5.8	0.4	–	–	–	–
Canada field pea (*P. arvense*), in bud,	2	85	1.1	3.2	4.1	6.1	0.5	2.6	2.5	4.3	0.3[1]
Canada field pea (*P. arvense*), in blossom,	3	87	1.2	2.8	3.8	4.8	0.4	2.3	1.7	3.6	0.2
Canada field pea (*P. arvense*), in pod,	2	84	1.2	2.3	4.8	6.3	0.4	1.9	2.2	4.8	0.2
English gray pea (*P. arvense*),	1	85	1.4	3.1	4.5	5.5	0.5	–	–	–	–
Prussian blue pea (*P. arvense*),	1	85	1.3	2.8	4.5	5.9	0.5	–	–	–	–
Flat pea (*Lathyrus sylvestris wagneri*),	2	85	1.3	4.4	3.7	5.0	0.6	–	–	–	–
Sainfoin (*Onobrychis sativa*),	1	75	2.1	4.4	6.0	11.6	0.9	–	–	–	–
Serradella (*Ornithopus sativus*),	3	85	1.6	2.2	4.4	6.5	0.3	–	–	–	–
Sulla (*Hedysarum coronarium*),	2	75	2.3	4.3	5.2	12.5	0.7	–	–	–	–
Spring vetch (*Vicia sativa*),	4	85	1.4	2.7	4.5	6.1	0.4	1.9	2.0	4.6	0.2

Winter or sand vetch (*Vicia villosa*),	7	85	2.1	3.4	4.4	4.7	0.4	2.8	2.8	3.6	0.3
Winter or sand vetch (*V. villosa*), in bud,	2	86	2.4	3.3	3.5	4.4	0.4	–	–	–	–
Winter or sand vetch (*V. villosa*), in blossom,	4	82	2.5	4.2	5.5	5.4	0.4	3.5	3.5	4.2	0.3
Kidney vetch (*Anthyllis vulneraria*),	1	85	2.0	2.8	2.3	7.4	0.5	–	–	–	–
(*d*) *Mixed and Miscellaneous.*											
Barley and peas,	1	80	1.6	2.8	6.8	8.2	0.6	2.1	3.5	5.6	0.4
Barley and vetch,	2	80	1.2	2.8	6.5	9.0	0.5	2.1	3.4	6.1	0.3 [2]
Corn and soy bean,	3	80	1.5	2.6	5.0	10.4	0.5	–	–	–	–
Corn and cow peas,	1	80	1.8	2.1	5.3	10.4	0.4	–	–	–	–
Sweet corn and cow peas,	1	80	1.5	1.8	4.8	11.4	0.5	–	–	–	–
Millet and peas,	1	80	1.8	2.4	7.5	8.0	0.3	–	–	–	–
Tall oat grass and alsike clover,	2	80	1.5	2.7	5.8	9.5	0.5	–	–	–	–
Orchard grass and alsike clover,	1	80	1.5	2.4	6.5	9.0	0.7	–	–	–	–
Peas and oats,	4	80	1.7	2.9	6.0	8.8	0.6	2.1	3.8	6.3	0.4
Sorghum and cow peas,	1	80	1.6	1.6	6.5	9.9	0.4	–	–	–	–
Vetch and oats (1–1),	3	80	1.8	3.0	6.3	8.4	0.5	2.3	4.3	5.7	0.2
Vetch and oats (1–4),	1	80	1.8	2.7	6.0	8.8	0.7	–	–	–	–
Wheat and vetch,	4	80	1.6	3.4	6.4	8.1	0.5	2.6	4.4	5.9	0.3
Apple pomace,	6	83	0.6	1.0	2.9	11.6	0.9	–	1.9	9.9	0.4
Sugar-beet pulp,	1	90	0.1	1.4	2.5	5.9	0.1	0.9	2.1	5.0	–
Cabbage waste,	1	82	4.9	3.6	2.6	6.6	0.3	–	–	–	–

[1] Same coefficients applied to Canada field peas in blossom and in pod.

[2] Same coefficients used as for barley and peas.

A. COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

NAME.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
I.—GREEN FODDERS—*Con.*											
(*d*) *Mixed and Miscellaneous*—Con.											
Carrot tops,	1	80	2.8	4.2	2.7	9.9	0.4	–	–	–	–
Prickly comfrey (*Symphytum asperrimum*),	1	87	2.8	2.3	1.5	6.1	0.3	–	–	–	–
Purslane (*Portulaca oleracea*),	1	91	1.5	2.3	1.6	3.4	0.2	–	–	–	–
Dwarf Essex rape (*Brassica napus*),	1	85	2.4	1.9	2.9	7.2	0.6	1.7	2.5	6.6	0.3 [1]
Summer rape (*B. napus*),	1	85	2.8	2.1	2.7	6.9	0.5	1.9	2.3	6.3	0.2
Winter rape (*B. napus*),	1	85	3.3	2.3	1.8	7.1	0.5	2.0	1.6	6.5	0.2
Sorghum (*Andropogon sorghum*),	7	80	1.3	1.7	5.5	11.1	0.4	–	–	–	–
Spurry (*Spergula arvensis*),	1	72	2.6	2.9	7.0	15.4	0.1	–	–	–	–
Teosinte (*Euchlæna Mexicana*),	2	70	2.3	2.3	9.4	15.6	0.4	–	–	–	–
II.—SILAGE.											
Apple pomace,	1	85	0.6	1.2	3.3	8.8	1.1	–	2.2	7.5	0.5 [2]
Corn,	47	80	1.1	1.7	5.4	11.1	0.7	0.8	3.5	7.7	0.5
Corn and soy bean,	6	76	2.3	2.7	7.3	10.9	0.8	1.7	4.5	8.5	0.7
Millet,	3	74	2.4	1.7	7.5	13.6	0.8	–	–	–	–
Millet and soy bean,	9	79	2.8	2.8	7.2	7.2	1.0	1.6	5.0	4.2	0.7

III. — Hay and Dry Coarse Fodders.											
(a) Meadow Grasses and Millets.											
Canada blue-grass (*Poa compressa*),	1	14	4.8	5.9	31.3	42.1	0.9	2.5	22.2	26.5	0.3
Kentucky blue-grass (*Poa pratensis*),	3	14	6.4	7.7	30.5	39.7	1.7	4.4	19.2	21.0	0.7
Canada hay,	4	14	4.6	6.1	28.1	45.1	2.1	–	–	–	–
English hay (mixed grasses),	102	14	5.3	7.9	27.7	42.8	2.3	3.7	18.0	25.3	1.0
Fermented hay,	1	14	6.3	8.4	25.4	43.7	2.2	–	–	–	–
Meadow fescue (*Festuca elatior pratensis*),	7	14	7.1	5.8	32.2	39.3	1.6	3.0	21.6	23.2	0.9
Millets. Barnyard grass (*Panicum crus-galli*),	1	14	8.6	13.1	29.0	33.6	1.7	–	–	–	–
Millets. Barnyard millet (*P. crus-galli*),	8	14	7.3	8.2	28.4	40.4	1.7	5.2	17.6	21.0	0.8
Millets. Hungarian grass (*Chætochloa Italica*),	3	14	6.3	8.4	24.6	45.0	1.7	5.0	16.7	30.2	1.1
Orchard grass (*Dactylis glomerata*),	7	14	5.9	8.3	29.9	39.3	2.6	5.0	18.2	21.6	1.4
Tall oat grass (*Arrhenatherum elatius*),	4	14	4.6	6.4	30.9	42.1	1.9	3.3	17.0	24.4	1.1
Red-top (*Agrostis alba vulgaris*),	6	14	4.6	6.5	28.5	44.9	1.5	4.0	17.4	27.8	0.8
Red-top (*A. alba vulgaris*), early cut,	1	14	4.3	5.8	30.9	43.3	1.7	–	–	–	–
Red-top (*A. alba vulgaris*), late cut,	1	14	4.1	6.0	31.0	43.2	1.7	–	–	–	–
Rowen,	29	14	6.4	11.4	23.9	41.3	3.0	7.9	15.8	26.4	1.4
Italian rye grass (*Lolium Italicum*),	4	14	6.4	7.1	28.6	42.2	1.6	–	–	–	–
Perennial rye grass (*Lolium perenne*),	4	14	7.9	10.1	25.4	40.5	2.1	–	–	–	–

[1] Same coefficients applied to all varieties of rape.

[2] Same coefficients used as for fresh apple pomace.

A. Composition and Digestibility of Fodder Articles — *Continued.*

	Name.	Number of Analyses.	Composition.						Digestibility.			
			Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
	III. — Hay and Dry Coarse Fodders — *Con.*											
	(*a*) *Meadow Grasses and Millets* — Con.											
Salt hays.	Black grass (*Juncus Gerardi*),	3	16	7.4	7.0	24.3	43.1	2.2	4.1	14.3	22.4	1.0
Salt hays.	Branch grass (*Distichlis spicata*),	2	16	7.6	6.8	22.4	45.1	2.1	3.8	12.1	22.1	0.7
Salt hays.	Flat sage (*Spartina stricta maritima var?*),	1	16	8.2	6.6	25.0	41.8	2.4	3.4	15.0	23.0	0.9
Salt hays.	Fox grass (*Spartina patens*),	2	16	5.8	6.7	22.5	46.9	2.1	4.0	11.9	24.9	0.8
Salt hays.	High-grown salt hay (largely *Spartina patens*),	1	16	7.0	6.3	22.2	46.4	2.1	3.8	11.8	24.6	0.8
Salt hays.	Cove mixture (black grass and red-top),	1	16	6.0	7.4	23.2	45.6	1.8	3.6	13.9	24.2	0.7
Salt hays.	Mixed salt hay (largely fox grass and branch grass),	1	16	8.4	5.5	22.5	45.5	2.1	2.3	13.1	23.7	0.6
Salt hays.	Salt hay (variety uncertain),	2	16	4.3	3.4	24.0	49.8	2.5	-	-	-	-
	Swamp or swale hay,	2	14	5.8	7.1	26.7	44.5	1.9	2.4	8.8	20.5	0.8
	Timothy (*Phleum pratense*),	8	14	4.2	8.4	28.1	43.4	1.9	4.0	14.1	26.9	1.0
	Timothy (*P. pratense*), early cut,	1	14	4.0	5.7	31.0	43.5	1.8	3.2	17.7	27.4	0.9
	Timothy (*P. pratense*), late cut,	1	14	3.9	5.2	29.7	45.2	2.0	2.2	13.7	26.7	1.0
	White-top (*Agrostis vulgaris var.*),	1	14	6.0	11.2	24.4	41.5	2.9	-	-	-	-

(b) Cereal Fodders.											
Corn stover, from field,	44	40	3.9	4.6	20.6	30.1	0.8	1.7	13.2	17.8	0.5
Corn stover, very dry,	44	20	5.2	6.1	27.4	40.2	1.1	2.2	17.5	23.7	0.7
Oats,	6	15	6.9	11.7	25.5	38.3	2.6	6.2	13.0	21.1	1.6
(c) Legumes.											
Alsike clover,	8	15	9.7	14.0	23.1	36.1	2.1	9.2	11.6	23.8	8.0
Mammoth red clover,	4	15	8.2	13.1	24.4	37.6	1.7	-	-	-	-
Medium red clover,	13	15	7.6	13.2	24.2	37.4	2.6	7.7	13.1	23.9	1.4
(d) Straw.											
Barley,	2	15	4.8	6.5	32.2	39.0	2.5	1.3	18.0	21.1	1.1 [1]
Horse bean,	1	15	8.1	8.3	35.2	32.1	1.3	-	-	-	-
Soy bean,	3	15	6.1	4.7	36.1	36.3	1.8	2.4	13.7	24.0	1.1 [1]
Millet (*Chætochloa Italica*),	1	15	5.3	3.6	35.2	39.5	1.4	-	-	-	-
Millet (*Panicum crus-galli*),	1	15	4.6	5.2	30.4	42.7	2.1	-	-	-	-
Millet (*P. miliaceum*),	1	15	5.2	3.3	35.9	38.1	2.5	-	-	-	-
Millet (variety uncertain),	1	15	5.8	4.2	35.5	38.3	1.2	-	-	-	-
Wheat,	1	15	4.1	6.2	30.5	42.8	1.4	0.7	15.9	16.3	0.4 [1]
(e) Mixed and Miscellaneous.											
Hairy lotus,	2	15	7.0	12.6	16.8	46.1	2.5	-	-	-	-
Oat grass and alsike clover,	2	15	6.5	11.6	24.5	40.1	2.3	-	-	-	-
Orchard grass and alsike clover,	1	15	6.6	10.1	27.6	38.3	2.4	-	-	-	-

[1] Coefficients taken from the German.

A. Composition and Digestibility of Fodder Articles — *Continued.*

Name.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
III. — Hay and Dry Coarse Fodders — *Con.*											
(*e*) *Mixed and Miscellaneous* — Con.											
Peas and oats,	4	15	7.2	12.2	25.5	37.5	2.6	8.9	14.8	22.9	1.5
Vetch and oats (1-1),	3	15	7.4	12.8	26.7	35.8	2.3	8.3	13.1	21.1	1.4
Wheat and vetch,	4	15	6.8	14.5	27.2	34.4	2.1	10.7	17.7	23.4	1.3
White daisy,	1	15	6.0	6.6	30.7	39.7	2.0	–	–	–	–
IV. — Vegetables, Fruits, etc.											
Apples,	2	78	0.7	1.0	1.5	18.3	0.5	–	–	–	–
Artichokes,	1	78	1.1	2.9	0.9	16,9	0.2	–	–	–	–
Beets, red,	7	88	1.1	1.5	0.7	8.6	0.1	–	–	–	–
Sugar beets,	13	86	0.9	1.6	0.9	10.5	0.1	1.5	0.9	10.5	0.1
Yellow fodder beets,	4	89	1.0	1.3	1.0	7.5	0.2	1.0	–	4.2	–
Cabbages,	1	90	0.8	2.6	0.9	5.5	0.2	–	–	–	–
Carrots,	5	89	0.9	1.0	1.1	7.8	0.2	–	–	–	–
Cranberries,	1	89	0.2	0.5	1.2	8.5	0.6	–	–	–	–
Mangolds,	5	88	1.2	1.4	0.8	8.5	0.1	1.0	0.3	7.7	–

Parsnips,	1	80	1.5	1.3	1.5	15.0	0.7	–	–	–	–
Potatoes,	22	80	0.9	2.1	0.5	16.4	0.1	1.0	–	14.8	–
Potatoes,	93	80	–	–	–	14.3 [1]	–	–	–	–	–
Ruta-bagas,	3	89	1.1	1.2	1.3	7.2	0.2	1.0	1.0	6.8	0.2
Japanese radish,	1	93	0.7	0.5	0.7	5.0	0.1	–	–	–	–
Turnips,	5	90	0.9	1.5	1.2	6.6	0.2	1.4	1.2	6.3	0.2
V.—CONCENTRATED FEEDS.											
(a) Protein.											
Horse beans,	1	14	3.8	25.8	7.0	48.6	0.8	–	–	–	–
Red adzinki beans,	2	14	3.6	21.0	4.0	56.7	0.7	–	–	–	–
Saddle beans,	1	14	5.3	13.0	4.1	49.4	14.2	–	–	–	–
Soy bean,	5	14	5.0	31.2	4.7	28.4	16.7	–	–	–	–
Soy bean (medium green),	2	14	4.6	35.6	3.9	24.6	17.3	32.4	–	19.9	16.1
Blood meal, Armour's edible,	3	11	3.1	84.3	–	1.2	0.4	70.8	–	–	–
Brewers' dried grains,	9	10	3.4	23.5	12.0	45.6	5.5	19.0	5.9	26.0	4.9
Brewers' wet grains,	1	77	0.7	6.7	3.8	9.8	2.0	5.3	2.0	5.7	1.8
Buckwheat feed,	2	10	3.2	15.9	22.0	44.8	4.1	–	–	–	–
Buckwheat middlings,	3	10	4.7	26.7	6.8	44.6	7.2	22.7	1.1	37.0	6.4
Cocoanut meal,	3	9	4.7	20.4	11.0	40.6	4.3	–	–	–	–
Cotton-seed meal,	319	7	6.6	45.3	6.3	24.6	10.2	38.1	2.2	19.2	9.6
Cotton-seed meal (low grade),	32	8	4.6	24.9	18.0	37.0	7.5	18.2	6.8	25.2	6.8

[1] Starch.

A. COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

Name.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
V. — CONCENTRATED FEEDS — *Con.*											
(*a*) *Protein* — Con.											
Dairy feed, H-O,	11	8.0	3.3	18.1	12.9	53.5	4.2	13.8	4.5	38.5	3.5
Distillers' dried grains, largely from corn,	56	8.0	1.7	31.7	12.3	34.2	12.1	23.1	11.7	27.7	11.5
Gluten feed,	192	8.5	1.7	26.2	7.2	53.3	3.1	22.3	5.5	47.4	2.6
Gluten flour, wheat,	1	5.5	0.4	84.8	0.2	8.1	1.0	-	-	-	-
Gluten meal, wheat,	2	8.0	0.9	39.8	0.8	48.9	1.6	-	-	-	-
Gluten meal,	138	9.5	1.0	36.0	2.1	49.1	2.3	31.7	-	43.2	2.1
King gluten meal (old process),	6	7.0	1.2	33.3	1.8	43.6	13.1	-	-	-	-
Germ oil meal,	13	9.0	2.7	22.7	9.3	45.9	10.4	15.7	-	37.2	10.1
Flaxseed meal,	2	7.0	3.5	23.5	5.5	23.3	37.2	-	-	-	-
Linseed meal (new process),	52	9.0	5.5	37.5	8.9	36.4	2.7	31.5	6.6	29.1	2.4
Linseed meal (old process),	113	8.5	5.2	34.3	8.6	36.5	6.9	30.5	4.9	28.5	6.1
Malt sprouts,	17	11.0	5.6	26.4	12.6	43.0	1.4	20.1	12.5	36.6	1.2
Bibby's dairy cake,	4	10.0	7.7	19.7	8.6	44.9	9.1	13.0	4.0	36.4	8.4
Blomo feed,	4	20.0	7.6	13.0	14.6	44.2	0.6	8.2	8.9	33.6	0.1

Holstein sugar feed,	1	8.0	6.7	12.6	10.0	60.0	2.7	8.3	4.4	48.6	2.4
Macon sugar feed,	2	6.0	6.6	14.0	10.2	61.6	1.6	8.3	4.5	50.5	1.3
Sucrene dairy feed,	8	10.0	6.3	16.6	11.7	52.1	3.3	10.1	8.4	38.0	3.1
Sucrene oil meal,	3	9.0	5.7	23.2	10.7	48.6	2.8	-	-	-	-
Oat middlings, fine,	4	9.0	2.3	15.8	2.4	64.3	6.2	12.8	1.2	61.7	5.8
Pea meal,	1	10.0	2.6	18.9	17.5	49.4	1.6	15.7	4.6	46.4	0.9
Peanut meal,	1	8.0	4.0	49.0	3.5	24.7	10.8	44.6	0.8	22.7	9.6
Proteina,	4	8.0	2.5	21.8	10.0	51.1	6.6	-	-	-	-
Rye feed,	15	11.0	3.2	14.7	3.8	64.6	2.7	11.8	-	56.8	2.4
Wheat middlings (flour),	106	10.0	3.2	19.2	3.2	59.6	4.8	16.9	1.2	52.4	4.1
Wheat middlings (standard),	308	10.0	4.3	17.9	7.0	55.8	5.0	13.8	2.1	43.5	4.4
Wheat mixed feed, bran and middlings,	732	10.0	5.3	17.0	8.2	55.0	4.5	13.2	5.1	42.4	3.9
Wheat mixed feed, adulterated,	7	10.0	4.3	12.3	15.5	54.6	3.3	7.7	4.3	38.8	3.0
Wheat bran,	379	10.0	6.2	16.3	10.0	53.1	4.4	12.6	3.9	37.7	2.8
Wheat bran (spring),	4	10.0	5.8	16.1	10.5	52.6	5.0	12.2	4.6	38.9	3.2
Wheat bran (winter),	3	10.0	6.2	15.3	8.6	57.0	2.9	11.8	2.3	37.1	1.9
(b) Starchy.											
Bakery refuse,	1	13.0	10.1	8.0	0.3	63.0	5.6	-	-	-	-
Barley,	6	12.0	2.4	11.2	5.7	66.8	1.9	7.8	2.9	61.5	1.7[1]
Broom-corn seed,	2	14.0	2.1	9.6	7.0	63.8	3.5	-	-	-	-
Buckwheat,	1	12.0	1.9	9.9	10.3	63.5	2.4	-	-	-	-

[1] Digestion coefficients taken from the German.

A. COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Continued.*

Name.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
V. — CONCENTRATED FEEDS — *Con.*											
(*b*) *Starchy* — Con.											
Cassava starch refuse,	1	12	1.6	0.8	6.1	78.8	0.7	-	-	-	-
Cerealine,	4	11	2.6	11.1	4.9	62.7	7.7	8.9	4.0	59.6	6.2
Cocoa dust,	1	7	6.3	14.4	5.5	42.7	24.1	-	-	-	-
Cocoa shells,	1	5	8.4	18.0	15.9	50.9	1.8	-	-	-	-
Cocoanut meat,	1	1	0.8	9.9	7.5	15.3	65.5	-	-	-	-
Corn bran,	2	11	2.0	10.8	12.4	59.8	4.0	5.8	7.3	46.0	3.1
Corn cobs,	6	8	1.3	2.7	31.3	56.2	0.5	0.5	17.8	27.0	-
Corn and cob meal,	38	11	1.4	8.9	6.7	68.4	3.6	5.0	3.1	60.2	3.0
Corn kernels,	93	11	1.3	10.2	2.0	71.6	3.9	-	-	-	-
Corn meal,	93	14	1.3	9.8	1.9	69.2	3.8	6.3	-	63.7	3.5
Sweet corn kernels,	3	11	1.9	12.5	2.4	64.9	7.3	-	-	-	-
Corn and oat feed,	48	10	3.0	9.1	9.9	64.8	3.2	-	-	-	-
Corn and oat feed (Victor),	39	10	3.5	8.6	11.3	62.9	3.7	6.1	5.4	52.2	3.2
Corn, oat and barley feed,	8	10	3.1	11.4	8.3	62.4	4.8	-	-	-	-

Corn, oat and barley feed (Schumacher's),	14	8	4.0	11.3	11.8	60.3	4.6	–	–	–	–
Corn screenings,	1	11	2.1	7.4	2.9	72.6	4.0	–	–	–	–
Cotton hulls,	5	11	2.6	5.3	39.7	39.0	2.4	–	15.9	16.0	2.1
Cotton-hull bran,	1	11	1.9	2.3	35.0	48.7	1.1	–	–	–	–
Cotton-seed feed,	4	11	3.1	10.5	36.0	35.9	3.5	5.4	16.6	19.8	3.0
Dairy feed (Quaker),	33	8	4.6	13.2	16.8	54.3	3.1	9.2	9.2	32.0	2.3
Flaxseed screenings,	1	7	5.4	15.7	16.5	44.5	10.9	–	–	–	–
Hominy meal,	120	11	2.5	10.4	4.2	64.1	7.8	6.8	2.8	57.0	7.2
Horse feed (H-O),	13	9	3.1	12.6	9.8	62.0	3.5	8.8	5.5	51.5	2.8
Maizeline,	1	5	2.7	10.0	7.9	66.0	8.4	–	–	–	–
Mellen's food refuse,	1	7	3.9	11.4	7.1	67.2	3.4	–	–	–	–
Millet seed,	4	12	2.6	11.1	7.7	62.9	3.7	–	–	–	–
Barnyard millet seed,	1	11	3.3	12.2	7.6	60.3	5.6	–	–	–	–
Molasses, Porto Rico,	2	24	6.8	3.1	–	66.1	–	–	–	–	–
Dried molasses beet pulp,	3	8	5.4	9.5	15.4	61.3	0.4	6.1	12.9	55.8	–
Oat kernels,	9	11	3.0	12.4	8.5	60.4	4.7	10.7	2.6	47.7	3.8[1]
Oats, ground,	9	12	3.0	12.3	8.4	59.7	4.6	10.1	1.2	51.3	3.7[1]
Oat feed,	110	7	5.3	8.0	21.5	55.3	2.9	5.5	7.1	28.2	1.5
Oat feed (low grade),	17	7	5.5	5.1	26.4	54.4	1.6	3.2	8.4	18.0	1.5
Oat feed, Canada,	2	7	5.4	13.2	24.8	44.7	4.9	9.1	8.2	22.8	4.3
Parson's "six-dollar" feed,	1	11	7.9	10.0	17.9	51.1	2.1	5.9	8.4	32.7	1.7

[1] Coefficients obtained from digestion experiments with horses.

A. COMPOSITION AND DIGESTIBILITY OF FODDER ARTICLES — *Concluded.*

Name.	Number of Analyses.	Composition.						Digestibility.			
		Water.	Ash.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.	Protein.	Fibre.	Nitrogen-free Extract.	Fat.
V.—CONCENTRATED FEEDS—*Con.*											
(*b*) *Starchy*—Con.											
Pea bran,	2	11	2.7	10.0	39.7	35.6	1.0	-	-	-	-
Peanut feed, largely husks,	2	10	2.6	8.9	56.4	16.6	5.5	6.3	6.2	8.1	5.0
Peanut husks,	1	13	1.2	5.0	66.0	13.1	1.7	-	-	-	-
Peanut shells,	2	7	2.8	7.1	62.2	19.0	1.9	-	-	-	-
Rice, cleaned,	1	11	0.3	8.5	0.1	79.8	0.3	-	-	-	-
Rice bran,	2	11	12.7	6.8	20.6	42.8	6.1	4.3	6.0	33.4	5.4
Rice meal,	2	11	8.2	11.8	5.3	50.8	12.9	7.3	-	46.7	11.7
Rye middlings,	1	11	3.6	11.7	3.3	65.4	5.0	-	-	-	-
Speltz,	1	8	3.9	11.5	11.1	62.9	2.2	-	-	-	-
Starch refuse,	2	12	1.8	4.8	3.8	76.3	1.3	-	-	-	-
Wheat kernels,	11	11	1.8	12.4	2.7	70.2	1.9	-	-	-	-
Wheat flour,	2	12	0.4	9.9	0.1	76.8	0.8	-	-	-	-

(c) *Poultry.*											
American poultry food,	14	8	2.9	13.1	6.5	63.6	5.9	-	-	-	-
Cut bone,	1	26	21.5	20.7	-	0.2	31.6	-	-	-	-
Raw ground bone,	1	8	64.4	23.9	-	3.4	0.3	-	-	-	-
Cut clover,	2	10	6.8	17.9	20.5	41.8	3.0	-	-	-	-
H-O poultry food,	3	9	2.7	17.4	4.4	60.2	5.3	-	-	-	-
Meat and bone meal,	37	6	37.4	39.5	-	6.3	10.8	-	-	-	-
Meat scrap,	11	9	17.6	50.8	-	4.5	18.1	-	-	-	-
Mutton scrap,	1	7	33.1	39.9	-	5.3	14.7	-	-	-	-
Granulated milk,	1	10	26.5	35.9	-	18.1	9.6	-	-	-	-

B. Fertilizer Ingredients of Fodder Articles.[1]

[Figures equal percentages or pounds in 100.]

	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
I.—Green Fodders.					
(a) Meadow Grasses and Millets.					
Orchard grass,	4	70	0.43	0.56	0.13
Millet,	1	80	0.29	0.43	0.11
Barnyard millet,	3	80	0.30	0.67	0.10
Hungarian grass,	1	80	0.30	0.42	0.12
Japanese millet,	3	80	0.33	0.22	0.10
(b) Cereal Fodders.					
Corn fodder,	22	80	0.39	0.30	0.13
Oats,	3	75	0.72	0.56	0.19
Rye,	2	75	0.27	0.57	0.11
(c) Legumes.					
Alfalfa,	4	80	0.44	0.31	0.11
Horse bean,	1	85	0.41	0.21	0.05
Soy bean (early white),	1	80	0.57	0.55	0.13
Soy bean (medium green), average,	14	80	0.64	0.53	0.14
Soy bean (medium green), in bud,	1	80	0.66	0.58	0.15
Soy bean (medium green), in blossom,	5	80	0.64	0.60	0.13
Soy bean (medium green), in pod,	7	78	0.72	0.52	0.17
Soy bean (medium black),	1	80	0.70	0.50	0.16
Soy bean (late),	1	80	0.60	0.68	0.14
Alsike clover,	6	80	0.53	0.50	0.15
Mammoth red clover,	3	80	0.50	0.27 [2]	0.12
Medium red clover, average,	10	80	0.52	0.57	0.11
Medium red clover, in bud,	2	80	0.58	0.71	0.13
Medium red clover, in blossom,	3	79	0.51	0.58	0.12
Medium red clover, seeding,	2	75	0.61	0.65	0.13
Sweet clover,	1	80	0.43	0.40	0.12
White lupine,	1	85	0.45	0.26	0.05
Yellow lupine,	1	85	0.40	0.44	0.09

[1] Many of these analyses were made in earlier years by the Massachusetts State Experiment Station. The percentages of the several ingredients will vary considerably, depending upon the fertility of the soil, and especially upon the stage of growth of the plant. In the majority of cases the number of samples analyzed is too few to give a fair average. The figures, therefore, must be regarded as close approximations, rather than as representing absolutely the exact fertilizing ingredients of the different materials. (J. B. L.)

[2] Evidently below normal.

B. Fertilizer Ingredients of Fodder Articles — *Continued.*

	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
I. — Green Fodders — *Con.*					
(*c*) *Legumes* — Con.					
Canada field peas, average,	6	85	0.50	0.38	0.12
Canada field peas, in bud,	2	85	0.50	0.44	0.11
Canada field peas, in blossom,	2	87	0.45	0.32	0.11
Canada field peas, in pod,	2	84	0.52	0.37	0.13
Cow pea, average,	9	85	0.45	0.47	0.12
Black cow peas,	4	85	0.40	0.47	0.12
Whip-poor-will cow peas,	5	85	0.49	0.47	0.12
Flat pea,	1	85	0.75	0.32	0.10
Small pea,	1	85	0.40	0.31	0.09
Sainfoin,	1	75	0.68	0.57	0.20
Serradella,	2	85	0.36	0.37	0.12
Sulla,	2	75	0.68	0.58	0.12
Spring vetch,	1	85	0.36	0.45	0.10
Hairy or sand vetch, average,	5	85	0.55	0.51	0.13
Hairy or sand vetch, in bud,	2	86	0.52	0.54	0.12
Hairy or sand vetch, in blossom,	3	82	0.65	0.57	0.16
Kidney vetch,	1	85	0.44	0.28	0.08
Average for legumes,	–	–	0.53	0.44	0.12
(*d*) *Mixed and Miscellaneous.*					
Vetch and oats,	4	80	0.30 [1]	0.30	0.14
Apple pomace,	2	83	0.21	0.12	0.02
Carrot tops,	1	80	0.69	1.08	0.13
Prickly comfrey,	1	87	0.37	0.76	0.12
Common buckwheat,	1	85	0.44	0.54	0.09
Japanese buckwheat,	1	85	0.26	0.53	0.14
Silver-hull buckwheat,	1	85	0.29	0.39	0.14
Summer rape,	1	85	0.34	0.78	0.10
Sorghum,	8	80	0.26	0.29	0.11
Teosinte,	1	70	0.47	1.18	0.06
II. — Silage.					
Corn,	7	80	0.42	0.39	0.13
Corn and soy bean,	1	76	0.65	0.36	0.35 [2]
Millet,	3	74	0.26	0.62	0.14
Millet and soy bean,	5	79	0.42	0.44	0.11

[1] Too low; 0.43 nearer correct.

[2] Evidently too high.

B. FERTILIZER INGREDIENTS OF FODDER ARTICLES — *Continued.*

	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
III. — HAY AND DRY COARSE FODDERS.					
(a) Meadow Grasses and Millets.					
Barnyard millet,	3	14	1.29	2.88	0.43
Hungarian grass,	1	14	1.29	1.79	0.52
Italian rye grass,	4	14	1.12	1.19	0.53
Kentucky blue-grass,	2	14	1.20	1.54	0.39
Meadow fescue,	6	14	0.93	1.98	0.37
Orchard grass,	4	14	1.23	1.60	0.38
Perennial rye grass,	2	14	1.16	1.47	0.53
Red-top,	4	14	1.07	0.95	0.33
Timothy,	3	14	1.20	1.42	0.33
English hay (mixed grasses),	13	14	1.34	1.61	0.32
Rowen,	13	14	1.72	1.58	0.48
Branch grass,	1	16	1.06	0.87	0.19
Fox grass,	1	16	1.18	0.95	0.18
Salt hay (variety uncertain),	1	16	1.05	0.64	0.23
(b) Cereal Fodders.					
Corn stover, from field,	17	40	0.69	0.92	0.20
Corn stover, very dry,	17	20	0.92	1.22	0.26
Oats,	3	15	2.45 [1]	1.90	0.65
(c) Legumes.					
Alsike clover,	6	15	2.26	2.10	0.63
Mammoth red clover,	3	15	2.14	1.16 [2]	0.52
Medium red clover,	10	15	2.21	2.42	0.47
(d) Straw.					
Barley,	2	15	0.95	2.03	0.19
Soy bean,	1	15	0.69	1.04	0.25
Millet,	1	15	0.68	1.73	0.18
(e) Mixed and Miscellaneous.					
Vetch and oats,	4	15	1.29 [3]	1.27	0.60
Broom corn waste (stalks),	1	10	0.87	1.87	0.47
Palmetto root,	1	12	0.54	1.37	0.16
Spanish moss,	1	15	0.61	0.56	0.07
White daisy,	1	15	0.26	1.18	0.41
IV. — VEGETABLES, FRUITS, ETC.					
Apples,	2	78	0.12	0.17	0.01
Artichokes,	1	78	0.46	0.48	0.17

[1] Too high; 1.90 nearer correct.
[2] Evidently below normal.
[3] Too low; 1.80 nearer correct.

B. FERTILIZER INGREDIENTS OF FODDER ARTICLES — *Continued.*

	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
IV. — VEGETABLES, FRUITS, ETC. — *Con.*					
Beets, red,	8	88.0	0.24	0.44	0.09
Sugar beets,	4	86.0	0.24	0.52	0.11
Yellow fodder beets,	1	89.0	0.23	0.56	0.11
Mangolds,	3	88.0	0.15	0.34	0.14
Carrots,	3	89.0	0.16	0.46	0.09
Cranberries,	1	89.0	0.08	0.10	0 03
Parsnips,	1	80.0	0.22	0.62	0.19
Potatoes,	5	80.0	0.29	0.51	0.08
Japanese radish,	1	93.0	0.08	0.40	0.05
Turnips,	4	90.0	0.17	0.38	0.12
Ruta-bagas,	3	89.0	0.19	0.49	0.12
V. — CONCENTRATED FEEDS.					
(*a*) *Protein.*					
Red adzinki bean,	1	14.0	3.27	1.55	0.95
White adzinki bean,	1	14.0	3.45	1.53	1.00
Saddle bean,	1	14.0	2.08	2.09	1.49
Soy bean,	3	14.0	5.61	2.12	1.82
Blood meal (Armour's),	1	11.0	13.55	0.18	0.26
Brewer's dried grains,	2	8.0	3.68	0.86	1.06
Cotton-seed meal,	130	7.0	7.16	2.01	2.86
Distillers' dried grains,	20	8.0	4.50	0.31	0.61
Gluten feed,	72	8.5	4.17	0.37	0.72
Gluten meal,	46	9.5	5.87	0.21	0.55
Linseed meal (new process),	21	9.0	5.97	1.42	1.79
Linseed meal (old process),	43	8.5	5.32	1.29	1.64
Malt sprouts,	12	11.0	4.32	2.00	1.56
Bibby's dairy cake,	1	10.0	2.94	1.67	2.07
Sucrene feed,	1	10.0	2.62	2.08	0.55
Pea meal,	1	10.0	3.04	0.98	1.81
Peanut meal,	1	8.0	7.84	1.54	1.27
Proteina,	1	8.0	3.04	0.58	1.02
Rye feed,	11	11.0	2.36	1.08	1.60
Wheat middlings (flour),	32	10.0	3.16	1.05	1.66
Wheat middlings (standard),	77	10.0	2.92	1.28	2.04
Wheat mixed feed,	223	10.0	2.76	1.43	2.57
Wheat bran,	98	10.0	2.63	1.40	2.82

B. Fertilizer Ingredients of Fodder Articles — *Concluded.*

	Number of Analyses.	Water.	Nitrogen.	Potash.	Phosphoric Acid.
V. — Concentrated Feeds — *Con.*					
(*b*) *Starchy.*					
Ground barley,	1	13.0	1.56	0.34	0.66
Buckwheat hulls,	1	12.0	0.49	0.52	0.07
Cocoa dust,	1	7.0	2.30	0.63	1.34
Corn cobs,	8	8.0	0.52	0.63	0.06
Corn and cob meal,	29	11.0	1.38	0.46	0.56
Corn kernels,	13	11.0	1.82	0.40	0.70
Corn meal,	3	14.0	1.92	0.34	0.71
Corn and oat feed (Victor),	2	10.0	1.38	0.61	0.59
Corn, oat and barley feed (Schumachers),	1	8.0	1.80	0.63	0.83
Cotton hulls,	3	11.0	0.75	1.08	0.18
Hominy meal,	49	11.0	1.66	0.78	1.25
Common millet seed,	2	12.0	2.00	0.45	0.95
Japanese millet seed,	1	12.0	1.58	0.35	0.63
Molasses (Porto Rico),	1	24.0	0.51	3.68	0.12
Dried molasses beet pulp,	1	8.0	1.60	1.47	0.16
Oat kernels,	1	11.0	2.05	–	–
Oat feed,	14	7.0	1.26	0.75	0.48
Oat feed (low grade),	15	7.0	0.88	0.70	0.35
Peanut feed,	2	10.0	1.46	0.79	0.23
Peanut husks,	1	13.0	0.80	0.48	0.13
Louisiana rice bran,	1	11.0	1.42	0.83	1.70
Rye middlings,	1	11.0	1.87	0.82	1.28
Damaged wheat,	1	13.0	2.26	0.51	0.83
Wheat flour,	2	12.0	2.02	0.36	0.35
(*c*) *Poultry.*					
American poultry food,	1	8.0	2.22	0.52	0.98
Meat and bone meal,	10	6.0	5.92	–	14.68
Meat scraps,	4	9.0	7.63	–	8.11
VI. — Dairy Products.					
Whole milk,	297	86.4	0.57	0.19 [1]	0.16 [1]
Human milk,	3	88.1	0.24	–	–
Skim milk,	22	90.3	0.59	0.18 [2]	0.20 [2]
Buttermilk,	1	91.1	0.51	0.05	0.04
Whey,	1	93.7	0.10	0.07	0.17
Butter,	117	12.5	0.19	–	–

[1] From Farrington and Woll. [2] From Woll's Handbook.

C. Analyses of Dairy Products.

[Per Cent.]

Name.	Number of Analyses.	Solids. Maximum.	Solids. Minimum.	Solids. Average.	Fat. Maximum.	Fat. Minimum.	Fat. Average.	Proteids (N. × 6.25).	Salt.	Ash.
Whole milk,	4,103 [1]	19.55	10.02	13.63	10.70	1.50	4.43	3.56 [2]	–	0.73 [3]
Human milk,	3	13.59	10.50	11.87	3.77	1.66	2.52	1.48	–	0.24
Colostrum,	2	24.75	21.25	23.00	3.00	3.00	3.00	2.84 [4]	–	1.00
Skim milk (largely from Cooley process),	358	10.48	7.68	9.20	1.80	0.05	0.32	–	–	–
Buttermilk,	31	9.86	6.83	8.33	0.38	0.11	0.27	–	–	–
Cream (from Cooley process),	203	32.78	18.12	26.10	25.00	10.53	17.60	–	–	–
Butter (salted),	149	94.84	82.55	87.28	89.33	75.94	83.04	1.10 [5]	3.14	–
Butter (fresh),	14	85.36	72.49	82.24	85.05	72.21	81.48	0.76	–	–
Milk powder (Creamora), one-third skimmed,	1	–	–	93.49	–	–	24.96	23.78	–	6.93
Milk powder (Milcora), skim milk,	1	–	–	90.17	–	–	0.38	30.89	–	8.88

[1] Largely station herd, Jersey blood predominating. [2] Average of 331 samples. [3] Average of 259 samples. [4] Nitrogen. [5] Curd and natural ash.

Coefficients of Digestibility of American Feed Stuffs. — Experiments made in the United States.[1]

J. B. LINDSEY AND P. H. SMITH.

Experiments with Ruminants.
Experiments with Swine.
Experiments with Horses.
Experiments with Poultry.
Experiments with Calves.

Complete through Dec. 31, 1905.

---

[1] Being a portion of the report of the Division of Foods and Feeding.

Experiments with Ruminants.

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
I. — Green Fodders.									
(a) Meadow Grasses and Millets.									
Grass, meadow, young,	1	1	69	-	-	65	74	72	55
Grass, meadow, young, dried,	1	1	71	-	-	71	77	73	60
Grass, timothy,	1	3	63—65 64	- -	31—33 32	48—48 48	54—58 56	65—67 66	52—54 52
Grass, timothy, rowen,	1	2	- -	65—67 66	- -	72—72 72	60—68 64	67—68 68	51—55 52
Barnyard millet in blossom (Massachusetts),	3	6	67—76 70	- -	45—67 56	58—70 65	71—77 73	65—77 71	54—67 58
Japanese millet, bloom to early seed (Storrs),	2	3	- -	62—66 64	52—58 55	45—57 50	59—63 62	64—68 67	60—72 68
Hungarian grass, early to late bloom,	3	8	61—71 66	61—74 68	- -	59—72 63	65—76 70	64—71 67	48—85 62
(b) Cereal Fodders.									
Barley fodder, bloom,	2	4	- -	62—71 67	- -	69—73 72	49—66 61	69—76 71	56—63 60
Barley fodder, seeds forming,	2	2	- -	66—71 58	40—44 42	67—71 69	47—65 56	- 74	48—50 49
Corn fodder, dent, immature,	5	14	64—74 68	- -	42—43 42	56—80 66	56—76 65	64—79 71	37—83 68

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
I. — GREEN FODDERS — *Con.*									
(*b*) *Cereal Fodders* — Con.									
Corn fodder, dent, milk,	3	9	70	-	-	61	64	76	78
Corn fodder, dent, mature,	9	17	68	72	34	53	57	73	74
Corn fodder, dent, mature, B. & W., coarse,	1	2	51—54 52	- -	- -	20—28 24	46—47 46	57—61 59	74—82 78
Corn fodder, Eureka silage, ears just forming,	1	3	64—69 67	- -	42—43 42	67—68 67	56—61 60	70—74 72	65—67 66
Corn fodder, Sanford, mature,	2	4	63—73 69	67—75 71	14—50 34	46—57 52	67—80 75	67—75 71	53—74 66
Corn fodder, sweet, milk stage,	1	2	77—78 77	- -	- -	77—78 77	74—76 75	80—81 81	73—74 74
Corn fodder, sweet, roasting stage,	9	12	- -	67—79 72	22—61 48	52—69 62	54—72 60	73—82 77	62—82 74
Oat fodder, bloom to early seeding,	3	5	- -	56—65 62	49—68 60	68—76 73	43—63 55	60—67 62	67—72 69
Rye fodder, heading,	1	2	73—74 74	- -	- -	79—80 79	80—80 80	70—71 71	74—74 74
Sorghum fodder, blossom,	1	2	73—73 73	- -	- -	51—56 53	74—75 75	78—78 78	81—82 81

Sorghum fodder, Early Amber, past blossom,	1	2	61—62 61	- -	- -	38—42 40	42—45 42	70—71 71	- 67
Sorghum fodder, average both samples,	2	4	67	-	-	46	59	74	74
(c) Legumes.									
Alfalfa fodder,	1	2	61—61 61	- -	40—40 40	73—75 74	42—43 43	71—72 72	38—39 39
Soy beans, variety uncertain, before bloom,	1	2	- -	64—67 66	- -	77—80 79	45—55 50	71—73 72	50—58 54
Soy beans, variety uncertain, seeding,	1	2	- -	61—63 62	- -	68—71 69	38—43 41	72—75 73	49—59 54
Soy beans, medium green, full blossom,	1	2	- -	62—63 63	22—28 25	76—78 77	45—49 47	69—73 71	46—54 50
Soy beans, medium green, seeding,	4	12	62—69 65	65—69 67	16—45 28	74—84 78	31—53 45	71—81 77	31—69 55
Clover, crimson, late blossom,	1	3	- -	68—70 69	- -	77—77 77	54—58 56	74—75 74	63—69 66
Clover, red, late blossom,	1	2	65—67 66	- -	- -	66—68 67	52—53 53	76—79 78	63—66 65
Clover, rowen, late blossom,	1	2	- -	60—62 61	- -	61—62 62	51—54 52	64—68 65	60—61 61
Clover, average two samples,	2	4	65—67 66	60—62 61	- -	61—68 65	51—54 53	64—79 72	60—66 63
Cowpeas, ready for soiling,	2	4	66—77 68	72—76 74	19—28 23	73—77 76	57—62 60	76—84 81	56—62 59
Canada field peas, before bloom,	1	2	68 -	71—72 71	- -	81—83 82	62—62 62	71—71 71	50—55 52
Canada field peas, bloom to seeding,	2	6	60—67 64	- -	26—45 37	79—83 81	40—52 45	72—80 76	45—64 55

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
I. — GREEN FODDERS — *Con.*									
(c) *Legumes* — Con.									
Spring vetch (*Vicia sativa*),	1	2	62—62 62	- -	- 17	71—72 71	42—46 44	75—77 76	57—60 59
Winter or hairy vetch (*Vicia villosa*), bloom,	4	14	66—78 71	- -	29—55 42	79—88 83	52—73 63	68—84 77	63—82 71
(d) *Mixed and Miscellaneous.*									
Apple pomace,	2	6	66—80 72	- -	24—63 49	- -	36—85 65	80—90 85	39—52 46
Barley and peas, bloom,	3	4	- -	55—71 65	52—55 54	73—81 75	38—61 52	56—76 68	54—65 59
Oats and spring vetch, bloom,	1	3	65—69 67	- -	49—55 53	73—76 75	65—72 68	66—70 68	42—52 47
Oats and peas, bloom,	2	5	69—72 70	67—69 68	45—52 49	68—82 74	54—70 64	66—77 72	51—74 64
Oats and peas, partly seeded,	3	5	- -	58—70 62	36—63 47	68—83 74	48—67 55	56—67 63	55—74 64
Dwarf Essex rape, first growth,	1	2	88—88 88	- -	76—77 76	90—91 90	90—90 90	94—94 94	54—55 54
Dwarf Essex rape, second growth,	1	2	81 -	- -	47—51 49	86—89 87	84—84 84	90—91 90	42—44 43
Dwarf Essex rape, average,	2	4	85	-	63	89	87	92	48
Winter wheat and hairy vetch,	2	5	68—71 69	- -	40—46 44	69—78 75	66—71 68	71—76 73	54—61 57

II. — Silage.									
Soy bean silage, goats,	1	2	52—66 59	- -	- -	71—80 76	47—62 55	46—58 52	66—77 72
Soy bean silage, steers,	1	2	50—50 50	- -	- -	54—56 55	42—44 43	61—61 61	47—52 49
Soy bean silage, mammoth yellow, bloom,	1	3	52—65 58	63—73 67	- -	57—69 61	51—67 59	74—80 76	48—60 52
Soy bean silage, average,	3	7	56	67	-	66	53	65	57
Soy bean and barnyard millet silage,	1	4	54—65 59	- -	- -	55—62 57	61—73 69	54—63 59	69—75 72
Soy bean and corn silage (9 beans, 14 corn),	4	8	62—73 69	71—75 72	39—48 42	54—68 63	51—73 62	73—81 78	67—91 83
Clover silage,	2	5	32—52 44	36—54 45	26—51 36	22—40 35	41—55 48	31—56 45	36—60 45
Corn silage, dent, immature, average all trials,	7	17	59—68 64	60—68 64	31—35 33	42—65 53	54—78 68	60—70 66	61—85 71
Corn silage, dent, mature, average all trials,	9	25	57—76 66	60—77 70	24—48 37	21—63 50	45—80 64	63—83 71	65—90 82
Corn silage, dent, Leaming, immature,	2	4	59—66 62	60—68 64	31—35 33	46—51 49	54—71 63	62—66 65	61—77 72
Corn silage, dent, Pride of the North, mature,	1	2	72—76 74	- -	24—28 26	- 45	72—73 73	81—83 82	72—82 77
Corn silage, dent, Virginia, mature,	1	4	57—74 64	60—75 66	- -	21—55 39	51—69 58	66—79 72	65—84 77
Corn silage, Sanford, ears glazing,	1	2	74—76 75	76—77 77	47—48 48	54—54 54	77—78 78	78—80 79	76—78 77
Corn silage, dent, average all trials,	16	46	64	70	37	49	65	69	77
Corn silage, flint, mature, small varieties,	4	11	68—78 75	66—80 77	- -	48—73 65	75—79 77	71—83 79	- 82

Experiments with Ruminants — *Continued.*

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
II. — Silage — *Con.*									
Corn silage, flint, large white, partly eared,	1	2	69—70 70	72—73 72	31—37 34	56—56 56	72—72 72	75—76 76	72—74 73
Corn silage, fine crushed, steers,	1	2	60—68 64	- -	- -	32—44 38	72—78 75	60—70 65	75—77 76
Corn silage, fine crushed, sheep,	1	2	51—56 54	- -	- -	21—22 21	59—68 64	53—57 55	67—69 68
Corn silage, mature, fed raw,	1	1	-	-	-	45	59	71	86
Corn silage, mature, cooked,	1	1	-	-	-	39	70	75	87
Corn silage, steamed,	1	2	73—74 73	75—76 76	46—50 48	53—57 55	75—76 76	75—77 76	90—90 90
Corn silage, sweet, mature,	1	2	67—70 68	68—72 70	- -	53—55 54	68—74 71	71—73 72	82—85 83
Kaffir corn silage, well matured,	1	3	54—56 55	56—59 57	- -	22—33 28	57—59 57	59—62 62	47—54 50
Oat and pea silage,	1	2	63—68 65	63—70 67	52—53 52	74—75 75	58—65 61	64—70 67	73—77 75
Cow pea silage,	1	4	59—60 60	- -	- -	57—58 57	50—54 52	72—73 72	62—64 63
Sorghum silage, well matured,	1	3	51—60 57	53—62 59	- -	6—13 9	51—63 58	59—67 64	53—60 56
Silage, mixture of corn, sunflower heads and horse beans.[1]	1	2	64—68 66	66—70 68	40—41 41	60—65 63	56—64 60	71—74 72	75—78 77

Silage, mixture of corn, sunflowers (whole plant) and horse beans.[1]	1	2	64—67 65	68—71 69	20—31 26	57—59 58	63—68 65	72—75 74	72—76 74
III. — HAY AND DRY COARSE FODDERS.									
(a) Meadow Grasses and Millets.									
Kentucky blue-grass (*Poa pratensis*), bloom,	1	1	56	-	42	57	63	53	43
Canada blue-grass (*Poa compressa*), bloom,	1	2	62—63 62	- -	42—42 42	43—44 43	70—71 71	63—63 63	36—39 37
Blue-joint, bloom,	1	2	67—70 69	68—71 70	- -	68—72 70	71—73 72	66—71 69	51—53 52
Blue-joint, past bloom,	1	1	40	42	-	57	37	43	37
Buffalo grass (*Bulbilis Dactyloides*),	1	1	55	-	6	54	65	62	62
Chess or cheat (*Bromus secalinus*),	1	1	45	-	23	42	46	49	32
Colorado upland hay (largely *Agropyrum tenerum*).	2	6	47—63 56	45—59 52	40—48 43	58—67 62	54—63 59	49—66 57	16—53 34
Crab grass (*Eragrostis Neo Mexicana*), ripe,	3	8	47—57 53	- -	29—52 43	30—56 58	50—66 60	50—59 53	30—52 43
Meadow fescue (*Festuca elatior pratensis*), bloom.	1	2	60—61 61	- -	- 46	51—53 52	- 67	58—60 59	53—54 54
Johnson grass (*Andropogon halepensis*),	2	3	57	-	-	40	68	57	38
Millets. Barnyard millet, well headed,	1	3	57—58 57	- -	63—64 63	63—64 64	60—64 62	50—52 52	44—50 46
Millets. Barnyard millet, just heading out,	1	2	59—62 61	- -	51—52 52	56—59 58	66—71 69	55—59 57	47—49 48
Millets. Cat-tail millet (*Pennisetum spicatum*),	1	2	61—64 62	- -	- -	61—65 63	65—68 67	58—60 59	45—48 46

[1] Proportion of one acre corn, one-fourth acre sunflower heads and one-half acre horse beans.

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III.—HAY AND DRY COARSE FODDERS—*Con.*									
(*a*) *Meadow Grasses and Millets*—Con.									
Millets. Golden millet,	1	1	54	-	31	23	56	58	49
Millets. Hungarian,	1	2	64—66 65	66—67 66	- -	- 60	67—68 68	67—67 67	- 64
Millets. Millet (*Chætochloa Italica*),	1	2	52—58 56	- -	16—32 24	30—32 31	60—66 63	52—59 56	48—52 50
Mixed grasses, rich in protein (8–10 per cent.),	15	60	54—65 60	60—66 62	37—53 47	34—65 57	49—70 60	56—67 61	41—58 50
Mixed grasses, timothy predominating,	5	10	49—59 55	51—61 58	16—36 30	37—54 47	46—50 65	56—66 59	34—57 45
Meadow, swale or swamp hay,	1	2	38—40 39	- -	- -	31—37 34	30—36 33	- 46	- 44
Tall oat grass (*Arrhenatherum elatius*), late bloom.	1	2	54—57 55	- -	39—43 41	- 51	53—57 55	56—59 58	54—58 56
Wild oat grass (*Danthonia spicata*),	2	3	60—68 64	61—69 65	- -	49—68 58	65—71 68	62—69 65	36—63 50
Orchard grass, ten days after bloom,	1	1	54	56	-	59	58	54	54
Orchard grass, stage not given,	1	2	57—60 59	- -	- -	60—60 60	60—67 64	55—57 56	55—57 56
Orchard grass, average both samples,	2	3	56	56	-	60	61	55	55
Pasture grass,	1	3	73	73	52	73	76	74	67

	Prairie grass (*Sporobolus Asper*),	1	1	56	–	25	18	61	61	57
	Red-top,	2	3	58—62 60	59—64 61	– –	60—62 61	61—62 61	59—65 62	44—59 51
	Rowen, mixed grasses,	3	12	– –	63—68 65	– –	– 70	62—72 66	60—69 65	44—51 47
	Rowen, chiefly timothy,	1	4	– –	62—67 64	– –	66—69 68	62—73 66	60—65 63	48—51 49
	Rowen, average all trials,	4	16	–	65	–	69	66	64	47
Salt hays.	Black grass (*Juncus Geradi*),	2	5	50—62 56	– –	67—71 69	53—63 58	50—66 59	46—59 52	37—51 44
Salt hays.	Branch grass (*Distichlis spicata*),	2	5	49—57 52	– –	– 58	– 56	48—57 54	45—55 49	27—42 35
Salt hays.	Flat sage (*Spartina stricta maritima var.*),	1	3	55—58 57	– –	61—62 62	50—55 52	60—61 60	54—57 55	33—40 36
Salt hays.	Fox grass (*Spartina patens*),	3	7	51—56 54	– –	57—59 58	56—63 60	46—60 53	51—55 53	17—51 36
Salt hays.	Salt hay mixture, fox and branch grasses, etc.,	1	2	52—56 54	– –	68—70 69	41—43 42	54—61 58	51—54 52	26—30 28
	Timothy, in bloom,	4	8	54—66 59	51—67 58	33—34 34	50—60 57	50—62 57	57—72 63	26—62 48
	Timothy, past bloom,	8	17	47—61 52	43—62 52	30—68 59	32—50 43	32—57 46	53—70 59	23—70 51
	Timothy, stage unknown,	1	4	57—62 59	57—62 59	47—54 50	38—41 40	– –	– –	– –
	Timothy, average all trials,	24	58	55	56	39	48	50	62	50
	Timothy fed with cotton-seed meal (16 hay, 1 meal).	1	2	52—56 54	– –	17—28 22	24—32 28	46—52 49	61—63 62	36—37 36
	Timothy fed with cotton-seed meal (12 hay, 1 meal).	1	2	49—55 52	– –	9—30 20	27—38 32	43—51 47	58—62 60	52—54 53

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. — HAY AND DRY COARSE FODDERS — *Con.*									
(*a*) *Meadow Grasses and Millets* — Con.									
Timothy fed with cotton-seed meal (8 hay, 1 meal), .	1	2	44—48 46	- -	3—10 6	18—23 21	40—44 42	53—56 54	42—45 44
Timothy fed with cotton seed meal (4 hay, 1 meal), .	1	2	45—46 46	- -	- -	4—4 4	42—43 43	56—75 57	44—66 55
Timothy fed with cotton-seed meal (2 hay, 1 meal), .	1	2	48—56 52	- -	- 13	- 13	34—44 39	65—71 68	72—74 73
Timothy fed with cotton-seed meal (1 hay, 1 meal), .	1	2	47—52 49	- -	19—23 21	- -	24—26 25	68—78 73	79—87 83
Timothy fed with cotton-seed meal, average all trials,	6	12	50	-	16	20	41	62	57
Timothy and clover, poorly cured, ...	1	2	54—55 55	- -	- -	37—38 38	52—54 53	- 60	- 58
Timothy and red-top, late bloom, ...	1	7	48—60 54	- -	11—24 19	35—43 39	49—63 55	55—66 60	28—51 42
Witch grass (*Triticum repens*), ...	2	4	60—63 61	61—64 62	- -	49—64 58	56—68 62	62—70 66	54—60 57
(*b*) *Cereal Fodders.*									
Barley hay, ...	1	4	59	62	-	65	62	63	41
Corn fodder, dent, immature, average all trials, .	6	15	51—70 62	51—71 63	39—47 43	20—67 50	45—77 67	55—70 62	44—84 65
Corn fodder, dent, immature, B. & W., ...	1	4	51—64 57	- -	- -	20—36 27	45—74 59	57—66 61	66—84 76

Corn fodder, dent, in milk,	5	11	59—66 63	- -	- -	44—51 50	50—71 64	61—69 66	67—79 75
Corn fodder, dent, mature,	10	30	57—70 66	- -	16—30 23	30—61 45	43—73 63	61—81 73	56—82 70
Corn fodder, flint, ears forming,	1	3	69—72 70	71—73 71	- -	69—73 70	72—73 72	71—73 71	63—71 67
Corn fodder, flint, mature,	5	11	63—73 70	- -	- -	56—79 64	69—80 76	63—78 71	59—79 71
Corn fodder, sweet, mature,	3	6	60—71 67	62—74 70	- -	54—73 64	70—77 74	57—73 68	63—71 74
Corn stover, dent, Pride of the North,	1	2	53—55 54	- -	29—33 31	45—45 45	58—63 61	53—55 54	63—66 65
Corn stover, Eureka silage, ears just forming,	2	4	54—64 59	- -	40—46 43	57—58 53	56—72 65	53—64 59	62—67 65
Corn stover, average all trials,	11	31	53—64 57	49—58 55	29—46 41	11—58 36	52—74 64	53—64 59	49—77 67
Corn stover, below ear,	1	2	64—69 67	- -	- -	15—27 21	71—75 74	65—73 69	79—80 80
Corn stover, above ear,	1	2	52—58 55	- -	- -	17—27 22	69—72 71	50—57 54	62—65 64
Corn stover, minus pith (by hand),	1	3	54—57 55	55—59 57	- -	16—28 20	60—65 63	55—58 57	70—75 72
Corn stover, minus pith, ground (Marsden's process),	1	3	63—64 63	- -	46—55 49	57—62 60	60—61 61	65—66 66	82—83 83
Corn stover, minus pith, ground (Marsden's process), steamed.	1	3	51—59 56	- -	47—55 50	59—60 60	37—54 48	57—62 59	70—85 80
Corn stover, minus pith, average,	3	9	51—64 58	55—59 57	46—55 50	16—62 47	37—65 57	55—66 61	70—85 78
Corn stover, blades and husks,	1	4	60—68 65	- -	15—35 23	41—55 48	67—76 73	64—71 66	53—64 58

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. — HAY AND DRY COARSE FODDERS — *Con.*									
(*b*) *Cereal Fodders* — Con.									
Corn stover, tops and blades,	1	2	59—60 60	-	-	34—37 35	71—72 71	62—63 62	71—72 71
Corn stover, leaves,	1	2	35—36 36	-	-	43—69 56	54—67 61	57—61 59	61—65 63
Corn stover, leaves,	1	2	62—67 65	-	-	28—41 35	75—80 78	66—70 68	32—39 36
Corn stover, leaves, average both trials,	2	4	35—67 61	-	-	28—69 46	54—80 70	57—70 64	32—65 50
Corn stover, husks,	1	2	71—73 72	-	-	24—35 30	78—81 80	- 75	23—42 33
Kaffir corn fodder,	1	4	59—62 61	-	5—11 8	34—42 38	56—63 60	64—68 66	57—67 61
Kaffir corn stover, shredded,	1	4	34—38 36	-	13—26 19	28—34 30	65—69 67	36—40 38	77—81 79
Kaffir corn stover,	1	1	63	-	43	30	67	67	60
Kaffir corn stover, average both trials,	2	5	37	-	24	34	67	60	75
Oat hay, bloom to milk,	2	6	31—39 35	30—61 35	33—54 43	47—66 57	54—71 58	47—58 53	44—65 58
Oat hay, milk to dough,	4	14	48—60 54	48—61 54	20—54 37	34—60 52	35—62 48	40—62 56	39—72 64
Oat hay, average all trials,	6	20	54	54	39	53	51	55	60

Oat straw,	1	2	49–72 60	51–58 54	–	–	57–58 58	62–65 63	30–41 38
Sorghum fodder, Minnesota Early Amber,	1	3	58–60 59	64–66 64	41–49 44	40–47 43	42–56 49	57–67 61	62–67 65
Sorghum fodder, leaves,	1	2	60–66 63	–	–	56–62 61	65–76 70	62–67 65	46–47 47
Sorghum fodder, bagasse,	1	1	61	–	–	14	64	65	46
(c) Legumes.									
Alfalfa, first crop, budded to full bloom,	8	17	56–74 63	–	34–67 56	61–84 71	31–65 49	65–76 73	23–61 41
Alfalfa, second crop, budded to full bloom,	6	13	58–67 62	–	52–70 51	64–81 76	41–49 45	70–79 75	34–42 42
Alfalfa, third crop,	1	2	56–60 58	–	40–49 44	68–70 69	26–40 34	71–71 71	39–45 42
Alfalfa, average three crops,	15	31	62	–	54	72	47	72	41
Alfalfa, average all trials,	21	39	62	–	56	72	47	72	43
Soy bean,	1	2	62–63 62	–	–	70–74 71	59–62 61	66–71 69	19–40 30
Clover, alsike, full to late bloom,	4	9	55–64 60	56–65 60	42	64–71 66	40–60 50	63–74 66	71–80 [illegible]
Clover, crimson,	3	5	57–65 62	62–72 66	–	64–76 70	32–52 45	61–74 69	31–64 44
Clover, red,	7	15	49–67 57	51–66 54	[illegible]–41 31	47–68 58	43–70 54	52–74 64	40–70 55
Clover, white,	1	1	66	67	–	73	61	70	51
Clover, cowpea,	2	4	–	62–80 70	42–50 46	69–79 74	43–51 47	62–64 63	56–67 60

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
III. — HAY AND DRY COARSE FODDERS — *Con.*									
(c) *Legumes* — Con.									
Cow pea,	1	2	- 59	- -	- -	64—65 65	41—45 43	- 71	46—54 50
Peanut vine,	1	2	59—60 60	- -	- -	63—64 63	51—53 52	69—70 70	62—70 66
Spring vetch (*Vicia sativa*),	1	2	65—67 66	66—68 67	52—53 53	69—71 70	54—61 58	71—72 72	70—72 71
Winter or hairy vetch (*Vicia villosa*),	1	6	68—71 69	- -	34—46 42	81—83 82	60—63 61	71—75 73	69—74 70
(d) *Mixed and Miscellaneous.*									
Buttercups (*Ranunculus acris*),	1	2	56	57	-	56	41	67	70
Cotton-seed feed (4 to 1),[1] sheep,	2	6	54—60 56	- -	23—35 28	36—45 41	51—60 56	57—60 59	86—94 91
Cotton-seed feed (5 to 1), steers,	1	3	42—45 43	- -	20—24 22	32—41 36	28—33 31	50—59 54	83—86 84
Cotton-seed feed (7 to 1) and (6 to 1), steers,	1	3	45—46 46	- -	- 28	44—46 45	34—40 37	50—51 50	81—82 82
Cotton-seed feed (4 to 1), steers,	1	2	54	-	46	54	45	58	85
Cotton-seed feed (3 to 1) to (2 to 1), steers,	2	9	54	-	32	64	47	54	85
Cotton-seed feed, average both (4 to 1) trials,	3	8	56	-	33	44	53	59	90

Cotton-seed feed, average all trials,	7	23	52	-	30	51	46	55	86
Cotton-seed hulls,	4	13	35—47 41	- -	- -	0—25 6	0.5—58 47	13—46 34	58—89 79
Oats and peas,	2	7	56—67 61	56—67 60	54—65 58	69—78 73	50—64 58	54—66 61	51—69 59
Oats and sand vetch,	1	2	55—55 55	56—56 56	43—46 44	64—66 65	48—50 49	58—59 59	58—67 63
Oats and spring vetch,	2	5	57—63 59	- 60	- 60	60—71 65	47—67 57	34—65 59	17—76 52
Oats and vetch, average,	3	7	58	58	56	65	55	59	55
Salt bush (*Atriplex Argentea*),	1	3	46—47 46	31—32 31	71—72 72	65—68 66	3—15 8	46—51 49	50—55 52
Wheat and sand vetch,	2	6	64—69 66	- -	33—60 47	70—77 74	63—66 65	67—71 68	62—67 64
White weed (*Leucanthemum vulgare*),	1	2	58	58	-	58	46	67	62
IV. — Roots and Tubers.									
Sugar beets,	1	2	94—95 95	98—100 99	- -	90—93 91	88—113 100	100—100 100	40—53 50
Mangolds,	1	2	77—80 79	83—87 85	- -	70—80 75	27—59 43	91—92 91	- -
Potatoes,	1	3	73—80 77	75—81 78	- -	43—45 44	- -	87—93 91	- 13
Ruta-bagas,	1	2	84—90 87	89—93 91	- -	75—86 80	61—87 74	94—95 95	77—92 84
English flat turnips,	1	2	91—95 93	93—99 96	- -	84—95 90	89—117 100	96—97 97	82—92 88

1 Four hulls to one meal.

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
V.—CONCENTRATED FEED STUFFS.									
(a) Protein.									
Soy bean meal, variety unknown,	2	3	75—79 78	- -	- -	89—91 90	0—73 33	68—73 71	81—98 89
Soy bean meal, medium green, coarse ground,	2	4	81—98 90	- -	42—77 57	88—95 91	- -	61—100 81	89—97 93
Bibby's dairy cake,	2	6	61—81 70	- -	18—44 33	58—76 66	1—68 46	71—88 81	84—99 92
Blood meal, Armour's,	1	2	- -	- -	- -	80—88 84	- -	- -	- -
Brewers' dried grains,	2	5	56—62 62	- -	- -	78—84 81	28—62 49	51—60 57	87—93 89
Buckwheat middlings,	1	3	71—79 75	- -	26—41 36	83—86 85	8—26 17	79—87 83	87—92 89
Cotton-seed, raw,	1	2	63—69 66	- -	- -	66—70 68	65—86 76	49—50 50	- 87
Cotton-seed, roasted,	1	2	53—58 56	- -	- -	44—50 47	62—69 66	50—53 51	68—75 72
Cotton-seed meal,	4	12	67—90 79	81—95 88	- 84	76—96 84	26—55 35	66—96 78	87—100 94
Cotton-seed meal, high grade (Maine),	1	2	90	95	-	83	-	96	100
Cotton-seed meal, medium grade (Maine),	1	2	67—79 73	73—83 78	- -	81—86 84	40—47 44	73—91 82	95—95 95

Cotton-seed meal, low grade (Maine),	1	2	60—63 62	62—67 65	- -	72—73 73	30—45 38	66—70 68	87—93 90
Cotton-seed meal, high grade, dark colored, slightly fermented (Maine).	1	2	81—91 86	85—95 90	- -	82—83 83	- -	90—100 95	95—100 98
Dairy feed, H-O,	2	4	65—65 65	- -	- -	68—80 76	14—43 35	67—75 72	83—88 84
Distillers' dried grains, brand R, largely from rye,	1	2	56—59 58	- -	- -	56—63 59	- ?	61—73 67	80—88 84
Distillers' dried grains, largely from corn,	8	17	70—89 79	- -	- -	66—80 73	59—100+ 95	69—97 81	88—98 95
Germ oil meal,	2	5	72—83 76	- 75	- -	65—77 73	- -	68—82 76	95—98 96
Gluten feed,	7	13	85—91 86	92—93 93	- -	85—86 85	- 76	89—90 89	- 83
Gluten meal,	4	8	75—95 87	- -	- -	86—93 88	- -	78—94 88	91—99 93
Linseed meal, old process,	1	3	75—82 79	- -	- -	86—93 89	38—71 57	76—79 78	85—92 89
Linseed meal, new process,	1	3	73—83 78	- -	- -	82—88 85	49—100 74	82—87 84	90—98 93
Linseed meal, new process, Cleveland flax,	3	9	76—88 83	- 79	- -	- 83	- -	- 79	- 87
Linseed meal, new process, average,	4	12	82	79	-	84	74	80	89
Malt sprouts,	1	1	67	68	-	80	34	69	100
Malt sprouts (Mass.),	1	3	75—89 82	- -	3—33 19	74—77 76	98—100 99	76—91 85	74—100 [illegible]
Maize feed (Chicago),	1	2	83—85 84	- -	- -	83—84 84	68—76 72	84—87 85	90—90 90

EXPERIMENTS WITH RUMINANTS — *Continued.*

KIND OF FODDER.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
V. — CONCENTRATED FEED STUFFS — *Con.*									
(*a*) *Protein* — Con.									
Oat middlings, fine,	1	2	88—91 90	- -	31—40 36	80—81 81	21—77 49	94—97 96	93—94 94
Pea meal,	1	2	85—88 87	86—89 88	- -	80—86 83	25—26 26	93—94 94	52—57 55
Cow pea meal,	1	2	85—88 87	- -	22—45 33	80—85 82	62—66 64	92—94 93	74—74 74
Rye feed, bran and middlings,	1	3	77—83 82	- -	25—48 35	78—82 80	- -	86—89 88	79—99 90
Wheat bran, spring,	3	7	62—70 67	69—74 71	20—32 25	74—82 76	22—76 44	70—80 74	38—83 63
Wheat bran, winter,	1	3	57—66 62	- -	- -	75—79 77	- 27	62—76 65	51—80 64
Wheat bran, average all trials,	4	10	66	-	-	77	39	71	63
Wheat feed flour,	1	2	67—67 67	70—70 70	- -	78—80 79	- -	73—78 76	- -
Wheat middlings, flour,	2	4	78—86 82	81—84 83	- -	82—91 88	33—40 36	84—91 88	82—88 86
Wheat middlings, standard,	2	6	-	73	25	77	30	78	88
Wheat mixed feed, bran and middlings,	2	4	71—78 73	73—81 76	34—43 37	77—79 78	47—79 62	74—79 77	81—92 87
Wheat mixed feed, adulterated with corn cobs,	1	3	59—65 62	61—67 64	28—34 31	62—63 63	17—36 28	68—74 71	91—93 92

(b) Starchy.									
Cerealine feed,	1	3	89—92 90	– –	– –	79—81 80	72—92 82	93—97 95	78—83 81
Chop feed, corn bran and germs,	2	6	71—92 80	– –	– –	56—77 67	54—70 62	64—92 84	61—86 82
Corn bran,	2	4	70—71 70	– –	– –	53—55 54	50—65 59	74—80 77	69—85 77
Corn cobs,	1	2	59—60 59	– –	– –	13—22 17	65—66 65	60—60 60	44—56 50
Corn meal, coarse,	2	4	74—93 84	75—94 86	– –	45—54 48	– –	79—91 86	– –
Corn meal, fine,	2	3	87—89 88	89—90 90	– –	48—63 54	– –	87—95 91	– –
Corn meal, average all trials,	9	21	74—98 88	75—94 90	– –	40—87 66	– –	79—100 92	71—99 91
Corn and cob meal,	1	3	74—83 79	– –	– –	43—65 52	2—86 45	86—91 88	82—85 84
Corn and oat feed, Victor,	1	3	74—76 75	– –	– –	66—75 71	36—58 48	81—85 83	84—88 87
Kaffir corn kernels,	2	6	29—58 43	– –	– –	28—54 41	– –	34—62 45	– –
Kaffir corn meal,	2	5	54—76 66	– –	– –	36—62 53	– –	67—84 77	25—62 46
White Kaffir heads,	1	4	14—35 24	– –	24—83 54	7—23 12	0—46 27	14—40 31	5—65 31
Dairy feed, Quaker,	3	8	58—64 62	– 52	– –	62—72 70	54—56 55	55—71 59	72—80 74
Hominy meal,	3	8	71—91 82	– –	11—60 37	54—74 65	2—100+ 67	82—94 89	88—95 92

EXPERIMENTS WITH RUMINANTS — *Concluded.*

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
V. — CONCENTRATED FEED STUFFS — *Con.*									
(*b*) *Starchy* — Con.									
Horse feed, H-O,	3	5	70—77 74	- 78	- -	62—81 70	52—59 56	79—85 83	74—87 80
Molasses Feeds. Alma dried molasses beet pulp,	1	2	82—87 85	- -	55—69 62	59—69 64	83—84 84	89—93 91	- -
Molasses Feeds. Blomo feed,	1	2	64—69 67	- -	31—32 32	61—64 63	51—72 61	73—79 76	14—17 16
Molasses Feeds. Holstein sugar feed,	1	3	70—74 71	- -	24—43 33	61—71 66	26—62 44	79—82 81	86—89 88
Molasses Feeds. Macon sugar feed,	1	2	69—72 71	- -	20—21 20	57—61 59	36—51 44	81—83 82	74—91 82
Molasses Feeds. Sucrene dairy feed,	1	2	67—72 69	- -	28—47 38	57—64 61	70—73 72	71—75 73	93—96 95
Molasses Feeds. Molasses feeds, average last three,	3	7	70	-	36	63	52	80	88
Oats, unground,	2	6	66—74 70	68—74 71	2—61 25	72—81 77	15—40 31	74—79 77	87—92 89
Oat feed, Royal,	1	3	42—51 47	42—53 48	33—40 37	64—72 69	20—43 33	50—54 51	86—92 88
Oat feed, excessive hulls,	1	3	29—38 34	- -	8—21 13	51—69 62	25—37 32	29—36 33	89—97 92
Oat feed, average last two,	2	6	40	-	25	65	32	42	90
Parson's " Six-dollar " feed,	1	2	55—56 56	- -	10—14 12	56—62 59	45—50 47	63—65 64	80—81 81

Peanut feed, largely husks,	1	2	32—32 32	- -	- -	70—71 71	10—13 12	41—58 49	90—90 90
Rice meal,	1	2	71—76 74	- -	- -	- 62	- ?	89—95 92	91—92 91
Rice bran,	2	4	56—66 62	- -	1—34 18	58—68 64	13—42 21	76—81 78	52—92 72
Rye meal,	1	2	85—90 87	- -	- -	83—85 84	- -	89—94 92	63—65 64
Rice polish,	1	2	82—83 83	- -	27—36 31	65—66 66	22—23 22	92—93 93	66—81 74
Experiments with Swine.									
Barley meal,	1	1	80	80	-	81	49	87	57
Linseed meal, old process,	1	4	76—79 77	- -	8—12 10	83—90 86	10—14 12	82—87 85	78—82 80
Maize kernels,	1	1	83	83	-	69	38	89	46
Maize meal,	2	2	89—90 90	91—92 92	- -	86—90 88	29—49 39	94—94 94	78—82 80
Maize meal with cobs,	1	1	76	77	-	76	29	84	82
Hog millet seed (*Panicum miliaceum*),	1	1	73	-	19	68	33	92	59
Pea meal,	1	1	90	92	-	89	78	95	50
Potatoes,	1	4	97	-	-	84	-	98	-
Wheat, whole,	1	?	72	-	-	70	30	74	60
Wheat, cracked,	1	?	82	-	-	80	60	83	70
Wheat shorts (middlings),	1	2	74—79 77	- -	- -	71—75 73	25—48 37	85—88 87	- -
Wheat bran,	1	2	54—78 66	- -	- -	74—76 75	30—39 34	56—75 66	65—78 72

Experiments with Horses.

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
Corn kernels,	1	2	71—78 74	- -	20—32 26	40—76 58	- -	85—92 88	43—52 48
Corn meal, same as above,	1	2	84—93 88	- -	- -	74—77 76	- -	93—99 96	70—76 73
Corn stover minus pith, ground (Marsden's process),	1	2	40—59 50	- -	6—37 22	65—70 68	38—71 55	39—54 47	48—72 60
Oat kernels,	1	2	67—77 72	- -	31—36 33	84—87 86	13—49 31	75—83 79	80—85 82
Oats, ground, same as above,	1	2	73—78 76	- -	9—49 29	81—83 82	0.6—28 14	85—87 86	79—81 80
Oats, average of both,	2	4	74	-	31	84	22	82	81
Timothy hay,	1	2	39—48 44	- -	29—39 34	18—24 21	37—48 43	44—50 47	44—51 47

Experiments with Poultry.

Kind of Fodder.	Number of Different Lots.	Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Ash (Per Cent.).	Crude Protein (Per Cent.).	Crude Fibre (Per Cent.).	Nitrogen-free Extract (Per Cent.).	Crude Fat (Per Cent.).
Corn kernels,	1	3	- -	- 86	- -	44—58 50	- -	90—96 92	88—95 92
Corn kernels,	1	5	- -	86—87 87	- -	80—87 84	1—25 15	88—91 89	81—87 85
Corn meal,	1	3	- -	- 85	- -	41—55 48	- -	91—92 91	92—94 93
Kaffir corn kernels,	1	3	- -	- 88	- -	50—55 53	17—22 20	94—98 96	71—73 74

Kaffir corn meal,	1	3	– –	– 87	– –	42—44 43	30—42 35	95—97 96	82—84 83
Meat,	1	2	– –	87—87 87	– –	90—91 91	– –	– –	86—87 87
Oats,	1	8	– –	60—68 64	– –	68—81 74	4—11 8	65—75 71	77—85 81
Cow peas,	1	3	– –	– 71	– –	32—48 40	2—43 18	86—88 87	87—90 89
Cow pea meal,	1	3	– –	– 72	– –	40—49 44	8—11 10	84—91 88	75—98 89
Wheat,	1	1	–	84	–	77	–	89	59

EXPERIMENTS WITH CALVES.

Whole milk,	2	8	– –	– –	– –	90—98 95	– –	– –	93—99 97
Pasteurized whole milk,	2	9	– –	– –	– –	88—95 93	– –	– –	91—99 95
Cooked whole milk,	1	3	– –	– –	– –	80—94 87	– –	– –	92—99 95
Raw skim milk,	1	3	– –	– –	– –	94—95 95	– –	– –	– –
Skim milk, with sheep,	1	3	96—102 97	– 100	46—74 62	93—96 94	– –	– 100	– 100

Literature. — The following publications have been consulted in compiling the foregoing tables of digestibility: —

Colorado Experiment Station, Bulletins 8, 93.

Connecticut (Storrs) Experiment Station, reports for 1894–96, 1898.

Illinois Experiment Station, Bulletins 43, 58.

Kansas Experiment Station, Bulletin 103.

Louisiana Experiment Station, Bulletin 77, second series.

Maine Experiment Station, reports for 1886–91, 1893, 1894, 1897, 1898, 1900; Bulletin 110.

Maryland Experiment Station, Bulletins 20, 41, 43, 51, 77, 86.

Massachusetts, Hatch Experiment Station, reports for 1895–99, 1901–05; Bulletin 50 and unpublished data.

Massachusetts, State Experiment Station, reports for 1893, 1894.

Minnesota Experiment Station, reports for 1894–96; Bulletins 26, 36, 42, 47, 80.

Mississippi Experiment Station, report for 1895.

New York Experiment Station, reports for 1884, 1888, 1889; Bulletin 141.

North Carolina Experiment Station, Bulletins 80*c*, 81, 87*d*, 97, 118, 148, 160, 172.

Oklahoma Experiment Station, Bulletins 37, 46.

Oregon Experiment Station, Bulletins 6, 47, 85.

Pennsylvania Experiment Station, reports for 1887–94, 1897, 1898, 1900–01, 1903–04.

Tennessee Experiment Station, unpublished data.

Texas Experiment Station, Bulletins 13, 15, 19.

Utah Experiment Station, Bulletins 16, 54, 58.

United States Department of Agriculture, Bureau of Animal Industry, Bulletin 56.

Wisconsin Experiment Station, report for 1889; Bulletin 3.

Wyoming Experiment Station, unpublished data.

INDEX.

INDEX.